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DIVISION OF VEGETABLE PATHOLOGY.

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THE JOURNAL OF MYCOLOGY:

DEVOTED ESPECIALLY TO THE STUDY OF FUNGI IN THEIR RELATION TO PLANT DISEASES.

EDITED BY

THE CHIEF AND HIS ASSISTANTS.

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EDITED BY

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ANNOUNCEMENT.

By a recent act of Congress the Section of Vegetable Pathology has been made a Division, thereby placing it on an equal footing with the other branches of the Department. In view of the fact that the change in name necessitates the inauguration of a new series of bulletins, it seems a fitting time to modify somewhat the manner of issuing the JOURNAL. In the future, therefore, it is proposed to issue this publication at least four times a year, but instead of having it appear quarterly, as heretofore, we shall endeavor to publish it whenever there is sufficient material on hand to warrant us in so doing. There will be no changes made in the paging of the present volume, which will continue until four numbers, counting the one previous to this, are issued.

A NEW HOLLYHOCK DISEASE.

Plate III.

BY E. A. SOUTHWORTH.

Five or six years ago a very destructive disease made its appearance among seedling hollyhocks in a few large greenhouses in this country; it has since extended to various places in New York and New Jersey, and has nearly put an end to growing hollyhocks for bedding in the Government propagating houses in Washington.

Only a few firms grow hollyhocks in the greenhouse for bedding purposes, but these few are in most cases losing nearly their entire crop; and a reputable florist reports that the disease has quadrupled the price of hollyhocks in New York in the last two years. This malady is entirely distinct from either the well known hollyhock disease of England (*Puccinia malvacearum*, Mont.) which swept through the country a few years ago and destroyed many of the hollyhocks growing in gardens, or from the spot disease caused by *Cercospora althæina*, Sacc., described by Dr. B. D. Halsted in the Garden and Forest, March 26, 1890.

EXTERNAL CHARACTERS.

The fungus may attack any part of the plant: when on the leaf it occurs in the form of a brown spot, which may increase in size until the whole leaf is either diseased or withered; when on the petiole, the leaf and part of the petiole beyond the point of attack shrivel up at once; when at the base of the petiole, on the young unfolding leaves, or on the main stalk of the plant itself, the fungus quickly runs down to the root and kills the plant. Wherever the stem or petioles are attacked they shrivel up; all flow of sap is checked and the part of the plant or leaf beyond this point must succumb. If the plant is very dry, the diseased parts dry up, but if grown in a moist place the trouble is aggravated by swarms of bacteria that attack the diseased portions and, instead of drying up, the plant seems to perish by a kind of wet-rot. When the plant has attained some size and firmness of texture, the surface of the petiole or stem sinks in at the point of attack, forming a distinct flattening or even a hollow. The color of these spots varies from a light-yellowish brown to black. Frequently the centers of the spots are rust-color, becoming entirely black later.

BOTANICAL CHARACTERS.

The disease is due to a fungus closely resembling the well known bean rust [*Colletotrichium Lindemuthianum*, (Sacc. and Magnus) Brios. & Cava.], but the brown setæ or bristles which accompany the spores are much more plentiful than in the bean fungus. No published record of the fungus could be found and I have designated it *Colletotrichium althææ*.* In structure the fungus resemles a *Glœosporium* except for the presence of the bristles in the fruit pustules. The spores of *Colletotrichium* in general are either acicular and curved or oblong. This belongs to the latter class.

The basidia and spores are formed beneath the cuticle, which is finally rutured (fig. 5); the setæ appear after the basidia but very early in the history of the fungus. On the older spots they may become so numerous as to make the pustules appear like minute black tufts of hair, and to give the center of the spots on the stems a black color.

The spores, produced by constriction from the stalks or basidia (fig. 2), are unicellular, sometimes becoming once septate at the time of germination. They germinate quickly in nutrient solutions, and by the use of a mixture of hollyhock decoction in agar agar the fungus may be brought

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* *Colletotrichium althææ*, n. s.—Epiphyllous and caulicolous, erumpent, forming brown spots on the leaves and light-yellowish brown to black sunken spots on the petiole and stalk. Spores irregularly oblong, frequently with a light spot in the center, granular, colorless singly, flesh-colored in mass, 11–28 by 5μ. Basidia colorless, regularly cylindrical, tapering slightly or rounded at the apex, at least slightly longer than the mature spore, borne on a thin layer of pseudo-parenchyma, simple, but may branch if placed in excess of moisture (fig. 2). Setæ dark brown, abundant, once or twice septate, usually colorless below, 60–109 by 3–5μ, appear later than the basidia.

to perfection in plate cultures. In germination (fig. 4) the spores send out one or two, rarely three, germ tubes, which are continuous at first and filled with granular protoplasm. Sometimes, probably under unfavorable conditions, a secondary spore may form on the end of the germ tube after it has grown for a short distance, and by the time this spore is formed the first spore is empty. The mycelium produced in this way frequently anastomoses, and even the spores occasionally do the same thing, only one of the anastomosing spores sending out a germ tube. In the plant the mycelium is colorless, sparsely septate, and full of vacuoles. It penetrates the cavities of the cells, running through the vessels of the wood as well as the more delicate tissues. The tissues infested by it soon collapse, the cells die, and if the fibrovascular bundles are involved, as they usually are, the ascent of sap is stopped. A few cells on the edge of the spot may usually be observed which are penetrated by the mycelium, but are not collapsed.

The germ tubes developing from the spores sown in culture media may soon become closely septate, or may develop into a mycelium in which septa are only rarely visible, becoming, however, more closely septate as it grows older. The diameter is variable, the larger and older branches being as much as three or four times as broad as the smallest. The older branches are often constricted at the septa and sometimes instead of a constriction at a septum one of the adjacent segments swells up, forming a pear-shaped expansion at the end. The mycelium is colorless at first but in culture media soon grows dark colored and the contents become filled with large oily looking drops. After two or three days it is conspicuous in culture media by its dark color. Where it radiates from a single point the dark color usually extends nearly to the circumference of the spot which is bounded by a light margin composed of the still colorless hyphæ. In about seven days from the time that the spores are sown there are fully developed spore-producing pustules containing setæ on the artificially produced mycelium. Fig. 5 shows one of these very young pustules. The character of spores, basidia, and setæ is essentially the same as on the plant; the basidia may grow a little longer and the setæ are distinctly longer than any seen on the hollyhock itself (cf. figs. 1 and 3). The pustules may develop to a very large size, becoming half as large as a pin-head. They are perfectly black to the naked eye except where the spores form a flesh-colored mass on the top.

These cultures were undertaken with the hope of ascertaining whether the setæ actually belong to the spore-forming fungus. In case of the *Colletotrichium* on the bean this has been questioned because the setæ are frequently present in such small numbers that they are overlooked. This fact led to the idea that they might be parasites, or rather that there were two distinct fungi, one living upon the other.

In cultures I was never able to make one of these setæ germinate, but in one culture there were what seemed to be brown setæ, sending out long branches from their free ends. These could not be called true setæ, however, for they were shorter and broader than the typical ones,

and did not taper towards the ends, neither were they connected with fruiting pustules, but were borne directly on the vegetative mycelium. In fact, they seemed to be short, brown, aerial branches which had grown out into colorless hyphæ. In all the cultures wherever a pustule was produced the setæ were present, and although none of them were made from single spores, there is every reason to believe that they were pure cultures of the spores. No setæ could be discovered among them when carefully examined with the microscope, and they are so large as to be easily visible, moreover the setæ are not easily detached from the mycelium or pseudo parenchyma at the base of the pustule, and in some cases the spores were merely floated off from the pustule, so that the black setæ could scarcely have been carried with them. Besides, as had been said, a microscopical examination of the cultures revealed only the spores present. The material did not give positive evidence that the setæ and basidia sprang from the same hyphæ, but some of the very young pustules made this almost certain. In case of a similar fungus on cotton, I have seen the setæ bearing spores similar to those borne on the basidia, but nothing of the kind could be seen in this case.

The time of reproduction in artificial cultures agrees exactly with that in nature. Sowing the spores on the leaves of healthy hollyhocks in a drop of water produced well developed pustules in seven days.

Owing to the similarity of this fungus to *C. Lindemuthianum* an attempt was made to produce it on bean pods; this was unsuccessful, but inoculations similarly made with spores of *C. Lindemuthianum* produced the spores of that fungus. The inoculations were made by putting the spores in incisions made with a flamed knife, attempts to produce the bean fungus by sowing the spores on the outside having failed in former experiments.

No trouble was experienced in producing the hollyhock disease on healthy plants. For the first experiment three perfectly healthy seedlings, growing in a shallow pot in one of the Department greenhouses, were selected. There were sixteen plants in the dish and they were so close together that their leaves were in contact. The bases of the plants where the young leaf was not yet unfolded, and the points of union of the blade and petiole of full grown leaves were chosen as points of infection. In a week each of these three plants were diseased at one or more of the inoculated spots, while the other plants in the same dish were perfectly healthy except for a few spots of *Cercospora* on some of the leaves. These spots were entirely distinct from those caused by the *Colletotrichium* spores, and there was no possibility of confounding the two fungi. Later, two of these infected plants were killed by the fungus passing down from the young leaf to the base of the plant. This experiment was repeated by inoculating other plants in the same dish and was successful each time. The fungus which developed on these plants agreed in every particular with the one in Henderson's greenhouses.

GENERAL NOTES.

A number of circulars were sent out to prominent florists asking as to their experience with the disease. Our answers revealed the following facts: (1) Comparatively few florists have ever had any experience with the fungus, but wherever it has made its appearance it has been exceedingly destructive, the losses varying from 25 per cent. to the entire crop. (2) No one who grows hollyhocks entirely out of doors reported the disease, but some of those who reported it on seedlings raised in the greenhouse said it also attacked plants which were raised out of doors and had never been in the house. At Henderson's greenhouses it disappeared at first after the plants were bedded, but last year, owing probably to the wet season, the disease reappeared very violently after the plants were in bud and nearly ready to blossom, killing them root and all. Another correspondent reported that it attacked and killed his plants that were raised entirely out of doors. (3) Putting diseased plants out of doors may check the disease in some cases, but this is very uncertain. (4) Heat and moisture are very bad for the plants; as little as possible of each should be given.

Three dozen perfectly healthy plants growing out of doors in a cold frame were picked out from some Bay Ridge, L. I., nurseries and sent to Washington for experiments with infection. They were not carefully taken up and consequently experiments were delayed until they should recover from the set-back in growth they had received. Half of the plants were potted and put in one of the Department greenhouses while the other half were planted out of doors. Instead of recovering, and before any attempts at infection were made, the plants in the greenhouse were attacked with the fungus and were dead in two weeks. Those out of doors also became diseased, but not so badly and lingered along for some time. These plants had never been in a greenhouse; they were sowed out of doors the fall before, and had lived through the winter in a cold frame. They did not become diseased from contact with other diseased plants, for except the fungus which was produced on the seedlings already mentioned, there was none in the Department grounds, and these plants were kept in another house at some distance from the first. This would look as if the fungus could more readily attack plants whose vitality is in some way decreased, and is a hint to hollyhock growers as to the manner of transplanting.

Raising plants indoors is almost necessary if the demand for bedding plants is to be met in the spring, and consequently those who wish to raise them for the spring trade must either have some remedy for the disease or give up the business. For the purpose of ascertaining whether fungicides which have been of value in other diseases would also answer in this, the following experiment was made in Henderson's greenhouse. Three hundred plants which had been taken out of the greenhouse and put out of doors were brought in and repotted without disturbing the roots. All the diseased leaves were picked off; they were then arranged in three lots of 100 each and placed far enough apart so

that no two plants were in contact. One hundred were left untreated; 100 were sprayed every other day with the ammoniacal copper carbonate solution, and 100 with Bordeaux mixture, 4 pounds of lime to 6 of copper. Only the upper sides of the leaves were sprayed at first, but later the spray was applied to both sides. The results of the experiment were only moderately satisfactory, due in some measure at least to this early exposure of the under sides of the leaves, but in June the plants were visited and the effects of the Bordeaux mixture could be seen for some distance, the lot thus treated being much more vigorous than the other two. The effects of the copper carbonate were not very apparrent. There were diseased plants among those treated with Bordeaux mixture, but the foreman of the greenhouses was so encouraged by the results that he had decided to spray the plants out of doors as well.

An experiment made at the Department by Mr. Galloway, on a smaller scale, was less successful. Plants which were dipped in the mixture developed the disease, but there is sufficient encouragement for florists to try the mixture thoroughly another year, taking especial care to spray both sides of the leaves. It is of prime importance to completely clear the greenhouses of all diseased plants and raise an entirely fresh stock. The spraying should begin as soon as the first leaves come out, and be repeated every other day.

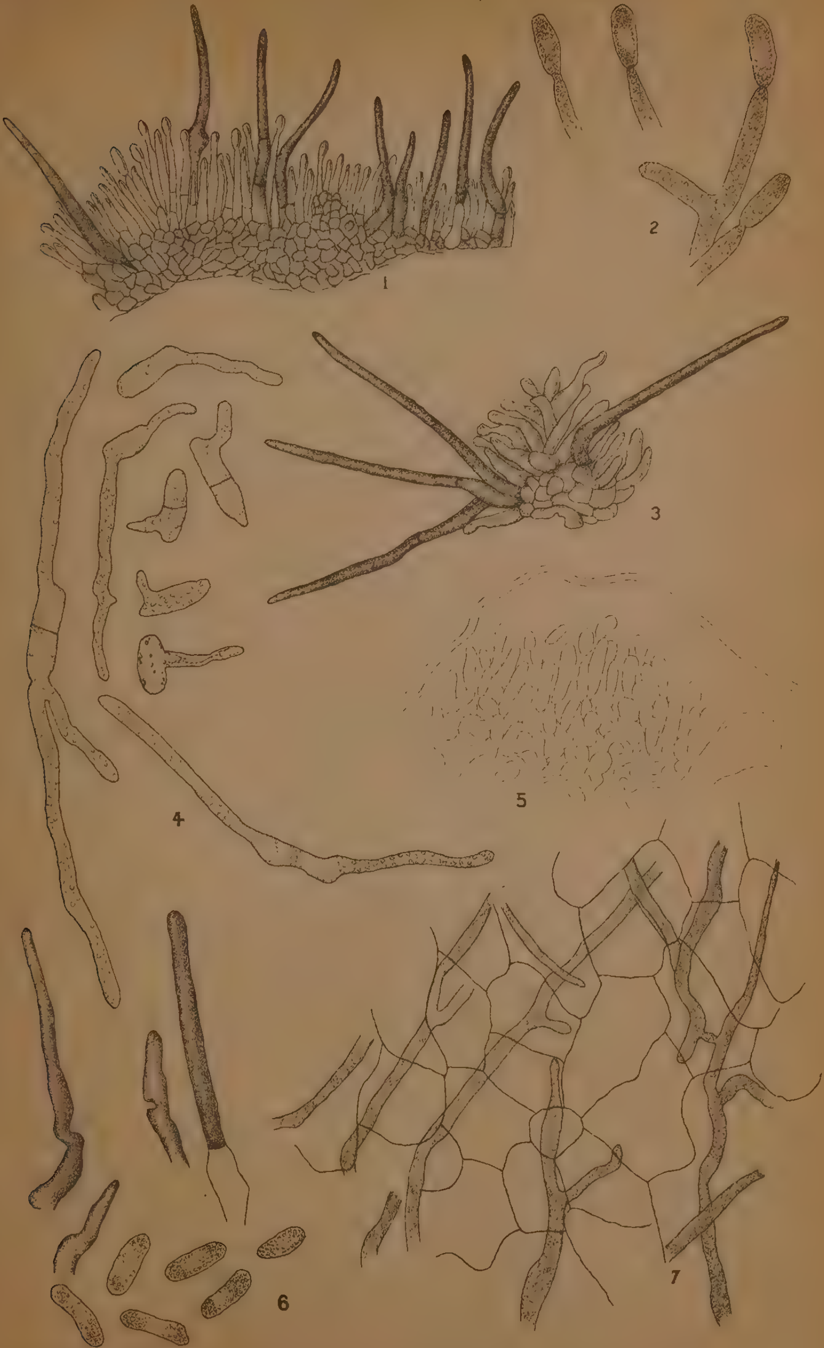
For applying the solutions on a small scale, any force-pump will answer, providing it is supplied with a suitable nozzle, such as the Vermorel or Japy. These can now be obtained from nearly all the large firms who deal in florists' supplies. Where the cultivation of the hollyhock is made an extensive business, the knapsack form of sprayer, such as described on page 51 of the present number, will be found very serviceable for applying the remedies.

EXPLANATION OF PLATE.

PLATE III.—*Colletotrichium althææ*, n. s.

FIG. 1. Section through fruiting pustule × 500.

2. Basidia bearing spores at their apices. The branched basidium was drawn from a specimen kept in a moist place × 600.
3. Small fruiting body grown on artificial substratum. It will be seen that the setæ are longer than in fig. 1, which represents the fungus on the plant, × 500.
4. Germinating spores, × 600.
5. Section through young fruiting pustule made before the epidermis had been ruptured × 600.
6. Setæ and spores × 600.
7. Mycelium in the tissue of a leaf as seen through the epidermis × 600.



E. A. S., del.

Southworth on Hollyhock Disease.

DESCRIPTION OF A NEW KNAPSACK SPRAYER.

By B. T. Galloway.

Since writing the note in the last Journal, relative to a new spraying pump designed by us, all parts of the machine have been perfected, and two firms in this city, Albinson & Company, 2026 Fourteenth street, and Leitch & Sons, 1214 D street, are now manufacturing it.

In view of the fact that any one has the privilege of making and selling this pump we have thought it best to give a detailed description of it, accompanied by illustrations of such a character that any intelligent machinist can use them as working drawings. The demand for the sprayer will be largely confined to the spring and early summer months, and to those who contemplate manufacturing it we will say that it is of the utmost importance to have the pumps in stock at this time. As a rule we find that the men who use machines of this kind wait until the last moment before sending for them, consequently they are anxious to have their orders filled promptly which, so far as our experience goes, is never done. Hence, therefore, the importance of having sufficient machines on hand to fill all orders without delay. Coming now to a description of the machine we have first:

The Reservoir (Figs. I and II).—This is made of 16-ounce copper, and

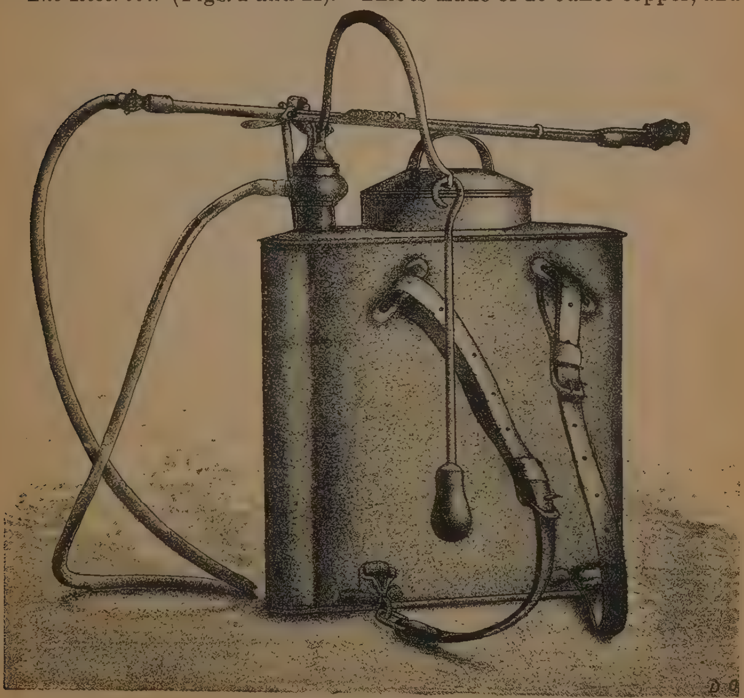


Fig. I.

holds a little over 4 gallons. We first tried 14-ounce copper, and found it too light, on the other hand 20-ounce seemed to be heavier than was necessary, so that we finally adopted the medium grade, which has given perfect satisfaction.

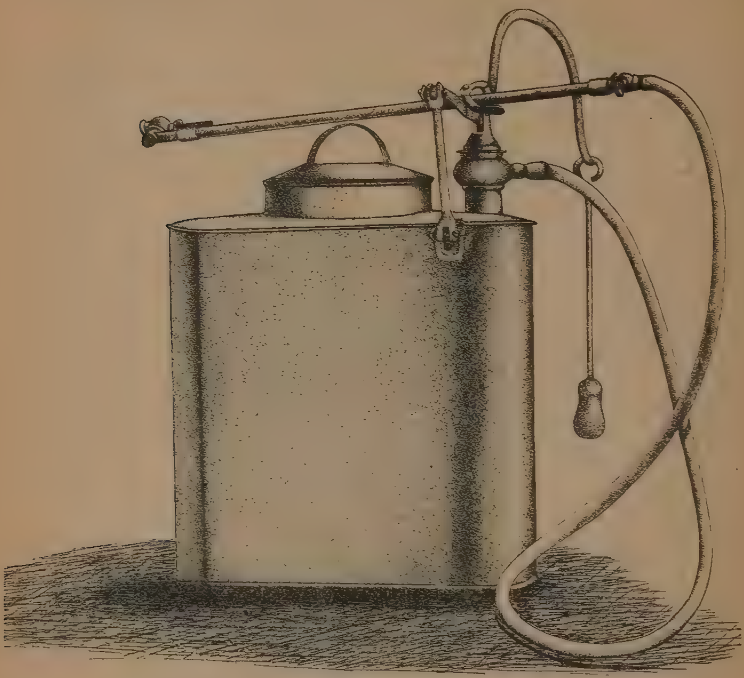


FIG. II.

The height of the reservoir is 16 inches, its breadth 15 inches, and depth 5 inches, 10 pounds of copper being necessary for a tank of these dimensions. When filled with the Bordeaux mixture, or any of the copper solutions now in use, the machine weighs practically 50 pounds, which is about as much as a man wishes to carry on his back for any length of time. In fact we find very few men able to carry such a load constantly for more than a few days at a time. This is why we did not make the reservoir larger, as some advised us to do, thinking one of 6 gallons' capacity about the proper size. Where the pumps are being used three days out of every fifteen, as is the case with many vineyardists, a 6-gallon reservoir would probably not be too heavy, but for a man using the machine six days in the week for three or four months, as must be done in large nurseries, it is simply out of the question.

The bottom of the reservoir as well as the top is soldered in, and, as is shown in Fig. III, the top is provided with two openings, one for the pump and the other for introducing the liquid. The pump orifice, *a*, is 1½ inches in diameter, while the opening for the liquid, *b*, is 4½ inches

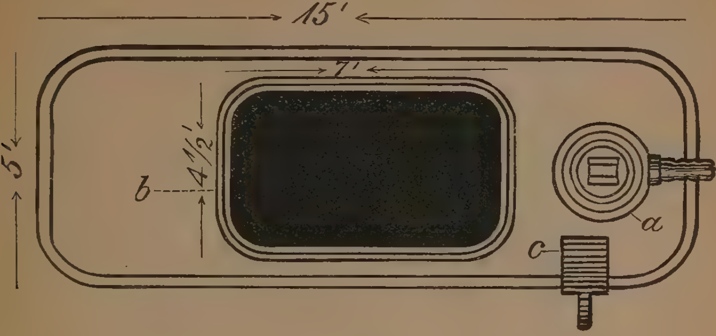


Fig. III.

wide by 7 inches long. Above and surrounding this opening is a rim 1½ inches high, into which is fitted a strainer, made of fine copper wire. The strainer, Fig. IV, rests on a slight projection made in the copper

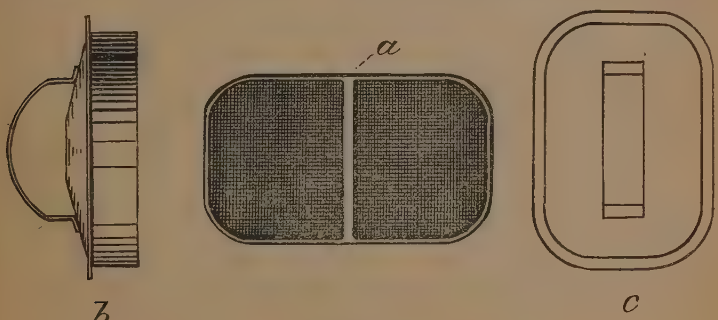


Fig. IV.

at the bottom of the rim, and is removed by means of a handle across the middle, *a*, Fig. IV. For closing the opening a lid made of copper, Fig. IV, *b* and *c*, is used, this fitting down tightly in the rim.

The Pump. (Fig. V.)—The pump is 17½ inches long and 1½ inches in diameter, and for making it 6 castings, weighing 2¼ pounds, 15½ inches of 1½-inch brass tubing and 14¾ inches of 1-inch brass tubing, are required.

It is not necessary to go into the details of the various parts of the pump, as the figures and explanations thereto will, we think, enable any one to understand the offices of the various parts. The pump is

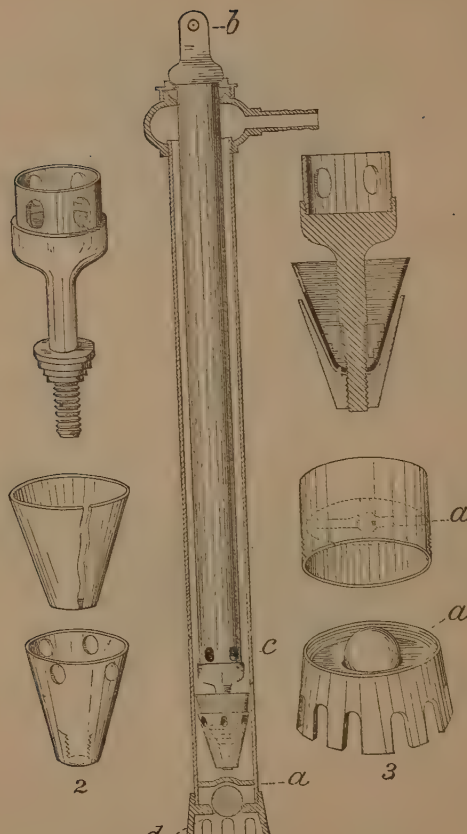


Fig. V.

soldered to the bottom of the tank, the solder being placed at the several points shown at *a* in Fig. VI.

It is fastened at the top, Fig. VI *b*, by means of solder also; for some reasons this is objectionable, but as it will not be necessary to remove the tube it is not a serious inconvenience after all. To obviate the difficulty, however, a nipple might be soldered in the tank at *b*, into which the tube could be screwed. The plunger is made in two styles, but for various reasons we have abandoned that shown in Fig. V, and now use only the form illustrated at VII. This is screwed to the end of the tube, the end being left open to do away with the necessity of side port-holes as shown at *c*, Fig. V. As seen in the cut, the plunger is not packed, the space *bb* being left for this purpose; ordinary wicking is used for packing.

In using the pump the hollow piston is drawn up creating a vacuum into which the liquid rushes through the opening *d*, Fig. V. The piston is then forced down and this closes the valve *d*, Fig. V, and opens the one at *a*, Fig. VII. This operation being repeated the liquid is forced out of the opening in a continuous stream, the latter being effected by means of the air-chamber in the piston. The figures show plainly the various parts necessary for working the pump, attaching the reservoir to the back, etc. We use as a rule about 4 feet of $\frac{7}{8}$-cloth insertion hose, and this is fastened to the pump and lance by means of copper wire.

Lance and Nozzle.—These are practically the same as described by us in a previous number of the JOURNAL,* the only difference being a change in the location of the spring which operates the degorger.

Summing up briefly the cost of such a machine as here described, we have the following:

10 pounds 16-ounce sheet-copper, at 23 cents per pound	$2.30
2½ pounds castings, at 25 cents per pound	.62
Castings and labor on lance	2.00
Straps and hose	.75
13 hours' labor, at 40 cents an hour	5.20
Total	10.87

* Vol. 5, No. II, p. 96.

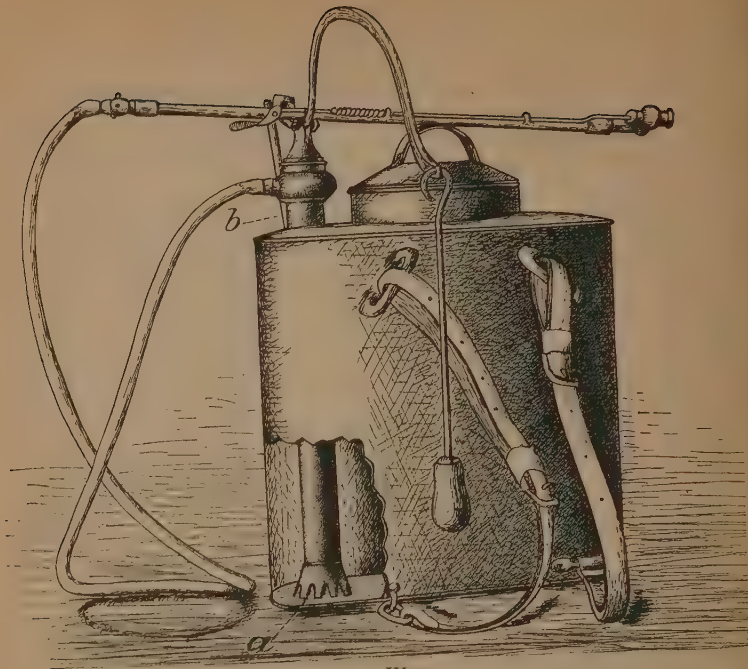


FIG. VI.

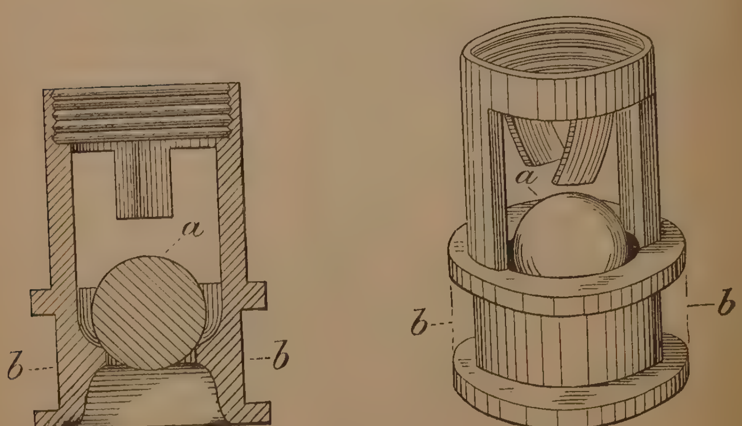


FIG. VII.

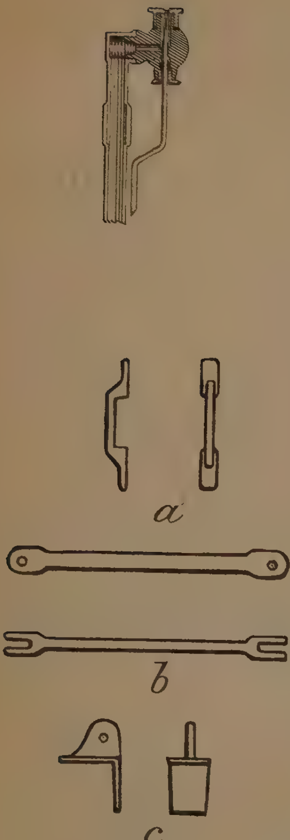


FIG. VIII.

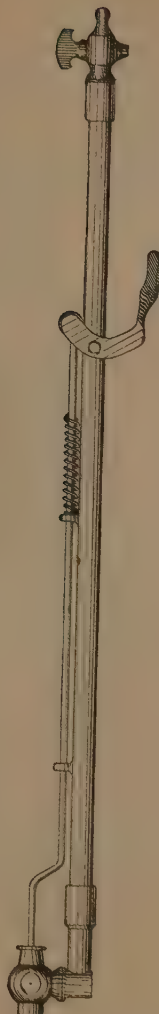


FIG. IX.

Fig. X.

EXPLANATION OF FIGURES.

FIG. I. Front view of reservoir showing straps and attachments, pump, handle, lance, and hose.

II. Back view of reservoir showing pump, handle, lance, hose, and fulcrum; also manner of attaching the latter.

III. Top view of reservoir. Top view of pump, opening 2½ inches in diameter *a*; opening for introduction of liquid, 7 inches long, 4½ inches wide, *b*; casting for holding the fulcrum, *c*; one-fourth actual size.

IV. Strainer, 7 inches long, 4½ inches wide, 1 inch deep; wire gauze soldered on the bottom, and handle *a* across the top; *b* and *c* lid, one-fourth actual size.

V. Pump complete. 1 one-fourth actual size; 2 and 3, one-half actual size. The plunger shown here has been abandoned and the one at Fig. VII substituted. The cross piece made of brass shown at *a* in 1 and 3 is retained in the new form. This piece holds the ball of the valve in place.

VI. Front view of reservoir showing pump inside; soldered at points seen at *a*.

VII. Plunger with ball valve showing ball at *a*, and space for packing at *bb*, actual size. The tube to which this is fastened is 14¾ inches long, making the total length with the piece marked *b*, in Fig. V, 17 inches.

VIII. Casting for attaching straps, *a*; fulcrum, *b*; casting which is soldered to reservoir *c*, as shown in Fig. II, and to which the lower end of the fulcrum is fastened by means of a bolt. All one-fourth actual size.

IX. Lance and nozzle one-fourth actual size.

X. Sprayer in use.

RECENT INVESTIGATIONS OF SMUT FUNGI AND SMUT DISEASES

AN ADDRESS DELIVERED BEFORE THE SOCIETY OF AGRICULTURISTS OF BERLIN FEBRUARY 17, 1888.

BY DR. OSKAR BREFELD,

Full Professor of Botany in Münster in W.

[Translated from *Nachrichten aus dem Klub der Landwirthe zu Berlin*, Nos. 220–222, by Erwin F. Smith.]

(*Continued.*)

As early as 1884 I began to make infection experiments on host plants, but soon, on account of the great number of details involved and the unimproved condition of my eyes, I was convinced that I could not carry through the experiments without assistance. Only upon my entrance into the Ministry of Public Instruction and transfer to Münster in Wesen was the help of an assistant in Mycology willingly granted me. This I had previously done without, having requested it of the Forest Department of the Ministry of Agriculture and been refused, although it was desired only as a compensation for my eye lost in direct government service. With this help, which I secured in the person of Dr. G. Istvanffi, privat docent in the University of Klausenburg in Hungary, I was able to bring the experiments to a relative conclusion.

But even four years ago I had carried on the culture of smut fungi in nutrient solutions for a long time, in order at least to make the first part of the investigations as complete as possible. I had cultivated the conidia of oat smut and corn smut from generation to generation for more than a year. Every four days the nutrient solutions were exhausted and the mass of yeast conidia was deposited in the culture as a distinct sediment. A few germs from the exhausted culture were always introduced by a needle-point into a new nutrient solution, and in another four days this was also exhausted. The serial cultures amounted to more than a hundred, which must have corresponded to about fifteen hundred continuous generations of the yeast conidia produced exclusively by sprouting. Yet the conidia produced in the last culture were of the same form as in the first. According to this, the sprout conidia in their unbroken succession are to be regarded as the exclusive product of the growth of these smut fungi in nutrient solutions *outside* of the host plants. This result is noteworthy in the same degree as the long-known fact that the smut spores are exclusively the form of the same smut fungi *inside* of the host plants.

Only this one change was to be observed in the continuous generations of the sprout conidia—they gradually pushed out into threads more slowly when the nutrient solution was exhausted. After ten months culture, after more than 1,000 sprout generations were formed, the germination in threads ceased entirely, the conidia swelled up somewhat and divided perhaps into two cells, but then remained passive. If we reflect that the conidia can penetrate into the host plants, to produce smut, only by means of their germ tubes, then with the disappearance of the tube germinations their infective power must also necessarily cease.

Consequently in the loss of this morphological character we have found a natural explanation for one of the much discussed special cases, viz, why the infective power of fungous germs should cease with lapse of time and with exclusive maintenance outside of the host. I will show later that as a matter of fact infections with these germs were without result, but first I will state briefly that in its composition and concentration the nutrient solution remained exactly the same during the entire period of the serial cultures; that therefore influences of nutrition and of the method of culture could not have brought about in the conidia the gradual cessation of thread germination.

The pure and satisfactory material from the sprout conidia of these smut fungi and of some others was also incidentally examined as to its possible power to induce alcoholic fermentation in nutrient solutions rich in sugar. But the forms investigated proved incapable of fermenting sugar, and could not grow at all in some of the larger masses of fluid. In these the sprouting remains nearly stationary and the germs finally die, probably from lack of sufficient access to air. From this behavior of the sprouts of the smut fungi in large masses of fluid

we can perhaps also judge of the behavior of the same germs in earth, and therefore in the soil of the field. It is scarcely to be supposed that the germs can be active in the deeper layers of the soil. It is much more probable that the condition for the vegetation of the smut fungi outside of the host plants is given only on the surface or in its vicinity, and that thence the host plants will be attacked by the smut germs.*

But, now, before I pass to the infection experiments, *i. e.*, to the production of smut diseases by infection with germs cultivated in nutrient substrata outside of the host plants, it may be judicious to state how extensive were the earlier experiments made directly and simply with the smut spores and to what results they have led.

When the smut spores dispersed in water were brought upon the surface of that part of the host in which in smutted plants the smut appears the result was purely negative; neither the penetration of the fungous germ into the plant, nor the subsequent sickening of the same, was to be observed. According to this the places where the smut shows itself in the full-grown host plants and the places where its germs penetrate into the plants could not well be the same. But neither on any other part of the full-grown plants was to be observed either the penetration of the germs or the subsequent appearance of the smut on the infected spots.

Following the earlier statements of Hoffmann it remained for J. Kühn of Halle, an eminent authority in the domain of Mycology and especially in that of smuts and smut diseases, to select young seedlings as the subjects for further experiments and observations. Kühn was the first who showed in the case of the stone smut of wheat the germ threads of the *Tilletia* in the young seedlings near the root node. Then he succeeded in doing the same thing in various forms of the genus *Ustilago*, after previous infection with the smut spores of these particular forms,—in *Ustilago maydis*, the corn smut, where three weeks after the infection he found a smut pustule in the young axis of the seedling, during the development of which the plant died; in *U. destruens*, *U. Crameri* and *U. Tulasnei*, on various kinds of millet seedlings (*Hirse keimlingen*); and also in the dusty oat smut, *U. carbo*, and in *U. bromivora* on *Bromus secalinus*. In each case he was able to establish the existence of the mycelium of the smut fungus not only in the root node and its vicinity, but also in the first stem node and sheath-leaf node and in the internode between these and the root node. Also at the same time, in these parts, he saw distinctly the points of penetration of the fungous germs.

From his numerous experiments lasting many years, by which he

* The experiments mentioned here upon the possible fermenting power of the smut yeasts, as well as the serial cultures themselves, were conducted with the most extraordinary care. The entrance of a single other yeast germ capable of causing fermentation would of course be enough to set up fermentation in the saccharine nutrient solutions and lead the experiments to wholly erroneous results.

also unquestionably showed the smut disease in the full-grown plants after previous infection of the seedlings, Kühn reached the conclusion that the regular way for a successful infection with smut fungi was through the axis of the host plant in the first stage of germination. Besides Kühn, R. Wolff also made successful infections with smut fungi in the botanical institute of De Bary in Halle. He repeated all the earlier experiments as to the places of penetration of the fungous germ into the host plants. In experiments which he made with *Ustilago carbo*, the dusty smut of oats, and *Urocystis occulta*, the stem smut of rye, he found that the germs of these fungi could not penetrate into the full-grown parts of the host plant; that only the *sheath leaf* of the young, just germinating host plants, is susceptible and shows clearly places of penetration. In his experiments he sprayed his young plants with smut spores dispersed in water, making use of an atomizer to secure fine droplets, which alone would adhere to the surface. The plants were then kept moist under a bell glass in order to favor the germination of the smut spores on the surface and the penetration of the fungous threads. According to the conclusion which the author draws from the sum total of his experiments, the penetration of the fungous thread takes place in the young sheath-leaf of the seedling, and here only. The germs which have penetrated grow crosswise through the young leaves of the seedling till they reach their subsequent nidus of development. This permeating growth was also observed directly in *Urocystis occulta*.

Moreover in this fungus, and only in this, was observed the appearance of the smut in full-grown rye plants which were infected in their youth. To these results reached by Wolff, viz., that the sheath leaf of the young grain plant is the only place of penetration of the smut germ into the host plants, and that the germs grow crosswise through the young seedling and penetrate to the apex of growth—Kühn soon after replied with his complete array of proof, satisfactorily maintaining and additionally fortifying his earlier view. He points out that infection through the sheath leaf, which Wolff assumes to be exclusive, is uncertain, and that while in *Urocystis occulta*, according to his numerous and many-sided experiments, smutted rye can be produced by infection of the sheath leaf, this is not possible in *Ustilago carbo* on barley, in *U bromivora* on *Bromus secalinus*, and in forms in which the ovaries alone are smutted. He then sums up his experiences as follows: In all smut fungi which do not live in leaves, the result of infection through the sheath leaf is uncertain. Since these experiments by Kühn, which were made public in the Natural History Society in Halle in the beginning of 1874, no further accounts by other authors of infection experiments with grain smuts have appeared.

For my experiments, to the communication of which I now proceed, I chose the dusty smut, *Ustilago carbo*, on oats and barley, the millet smut, *U. cruenta* on *Sorghum saccharatum*, and finally the corn smut,

U. maydis on *Zea mays*. The first two smut forms will answer as types for smut fungi living solely in the grain, the last form as a type for smut forms which may appear not only in the grain but also in every part of the host plant, from the period of its earliest youth to complete development. All these forms belong to the genus *Ustilago*, and yield by the cultivation of their spores in nutrient solutions an endless sprouting of yeast conidia as experiment material.

The agriculturists, who listen to me, will perhaps ask themselves the question, Why not then make the experiments with the stone smut of wheat, the most important smut form upon the grains of this country? To this I will reply at once that stone smut was purposely neglected for reasons not far to seek. The stone smut of wheat, belonging to the smut genus *Tilletia*, is not a suitable object for experiment, first, because, as infective material, its conidia, cultivated in nutrient solutions and "reproduced mold-like in the air" can not be distributed so evenly and well upon the host plants, on account of their difficult dissemination and use in fluids, as can the the sprout conidia of the genus *Ustilago* which are developed under fluids; second, because in *Tilletia*, especially, the observation of the penetration of the germ into the host plant, and the further development of this within the host, is surrounded with the greatest difficulties on account of the extraordinary minuteness of the *Tilletia* germs and mycelia. Finally, it is yet to be added that in its appearance as a parasite, in the exclusive formation of the smut beds in the ovaries of the wheat, the stone smut agrees throughout with oat and millet smut, so that the results obtained in infection experiments with these plants will also unquestionably answer for the stone smut of wheat.

I will now first describe in detail the execution of the infection experiments and will add to this the results which were obtained in the different series of experiments with the isolated smut forms named.

In order to procure sufficient infective material, by the cultivation of smut spores in nutrient solutions, I proceeded in the following manner: Having the year before with the greatest care procured pure and ripe smut masses, I allowed single spores of *Ustilago carbo*, *U. cruenta*, and *U. maydis* to germinate in March or early in April in nutrient solutions on glass slides. After I was convinced, by exact observation, of the entire purity of the cultures and of the sprout conidia developed in them, I introduced a few of these conidia by means of a flamed needle into small, shallow flasks, with broad flat bottoms and short necks, constructed for the purpose, in which I had previously carefully sterilized thin layers of nutrient solutions. The sprout conidia so transferred which, in these flasks, were under the most favorable conditions for their increase by sprouting, exhausted the nutrient solutions in the flasks in three days' time and then accumulated on the bottom as a distinct precipitate. By samples taken out it was easily possible to convince one's self of the continued purity of the culture, because

the sprout conidia of the different kinds of smut fungi named always possess a definite and characteristic form, and intruding germs can be distinguished without difficulty. It was no trouble to keep unlimited quantities of these conidia, since a large number of these flasks for securing the material for infections were always prepared at the same time, in order subsequently to unite the sprout conidia out of these different flasks.

From the previously more fully described details as to the development of these fungi through the sprouting of their conidia, we now know that the multiplication ceases with the exhaustion of the nutrient solution, and that when this happens there immediately occurs a pushing out of the conidia into germ threads, which in turn, in the space of at most two days, lengthen out, but then cease to grow, and gradually perish. By means of these threads must the fungous germs penetrate into the host plants, when they begin to germinate upon their surface. Since the development into germ threads immediately stops the increase of conidia by sprouting, and since the germ threads, as they continue to develop, grow into the host plants, it follows that the sprout conidia must be transferred to the host plants, if the infection is to be attended with the best results, at a time when they are still sprouting and have not yet grown out into threads. The conidia which have already grown out into germ threads are very liable to injury by their transferrence to the host plants, and as soon as they have grown out are scarcely able to penetrate into the latter. The most favorable period for infection is very transitory in the rapidly growing conidia, and if it is missed, a normal success of the experiment is not to be expected. In view of this, the necessary precautions were taken to have the plants which were to be infected always ready in the various stages of development required for the individual experiments at the same time that the sprout conidia just described had reached their most favorable point of development for infection.

The transfer of the sprout conidia to the host or experiment plants was done with the help of an atomizer which Wolff had already used in his infections with smut fungi, and which I had myself formerly put to manifold uses in my mycological investigations. The sprout conidia from the different culture flasks were quickly united in one flask, in the neck of which the atomizer, cautiously tested for satisfactory performance, had been adjusted beforehand. Without the use of an atomizer it is impossible to bring the fungous germs upon the experimental host plants in the necessary degree of dispersion. Only in the tiniest drops do the sprayed fluids remain sticking to the parts of the plant upon which they have fallen; in case of larger droplets there occurs at once a union into drops which flow off, and consequently hinder the development on the plant and the penetration into it of the germs transferred with the droplet.

But it is now known that fungous germs are easily injured when taken in full vegetation and suddenly transferred from nutrient solu-

tions to pure water. They frequently die or, at all events, experience a weakening in their further development. In order to avoid these possible injuries to the sprout conidia of the smut fungi, I transferred the germs while still sprouting vigorously, from the culture flasks to the atomizer with the precaution to place in this first a diluted and sterilized nutrient solution. I knew to a certainty by previous experiments that in this the sprouting germs would not be injured, but rather would continue to sprout for a short time so far as the nutrient substances made this possible. In this way, it is true, a new source of error, the loss of time, is introduced, namely, the time in which the germs, sprayed upon the host plants by the atomizer, continue to sprout in the surrounding droplet before they grow out into germ tubes. However, without this error the experiment sometimes fails, because we can not spray into the host plant or administer to it the fungous germs in such ways as is customary in experiments with animals, but must apply them externally. The mixing of the fungous germs with the diluted nutrient solution in the atomizer can be regulated at pleasure according to the quantity of the germs. The mixture was always exactly tested before each experiment and not used until the trials each time had shown that at least thirty germs were present in the tiniest mist-like droplets.

The infection itself, to wit, the spraying with the fungous germs, was performed in shallow tin boxes made for the purpose. In this the nascent seedlings of the host plant were placed entirely uncovered, on soil from the field, and after the spraying, could be kept by means of a glass plate cover in a uniformly and suitably damp atmosphere at about 10° C. This was to hinder the evaporation of the sprayed droplets and at the same time to favor the development of the sprout conidia into threads and the penetration of these into the host plants. After 10 to 12 days the infected plants were set out in the open field, so as to make possible their full development and at the same time to give an opportunity for the development of smut in their spikes. But even with these very careful methods there were still serious obstacles to the success of the infection. The young seedlings exude, through stomata, especially at the apex of the shoot, drops of water which in running easily wash away the fungous germs which have been sprayed on, and in consequence may hinder their penetration and thus affect the result of the experiment. This and the already intimated sources of error in infections, *i. e.*, in the transference of the germs directly to the seedlings, make it probable at first sight that the infection will not succeed equally well in all the plants used for experiment, but rather that it will be successful only in a portion of these. But this indefinite per cent. of accidents is still further much increased by the circumstance that in the different forms of grain-smut the receptive stage in the seedling is so very transitory that (as later results of experiments show conclusively) only those fungous germs which penetrate into the just developed seedling above the root node, and in this

way reach the apex of growth, finally come to development in the heads of the grain; all others fail.

With this, we come to the penetration of the smut germs into the host-plants, so often vainly looked for until the investigations of Kühn and Wolff threw additional light upon the subject, and till Kühn proved the penetration into the young seedlings, especially in the vicinity of the root node. Wolff later announced and represented in his drawings the penetration exclusively into the sheath leaf. Both observers in their investigations had naturally worked only with smut spores germinating imperfectly and irregularly in water.

For my observations I first began with very young seedlings. As soon as the plumule appeared (and the roots usually preceded this by a day or two) these seedlings were laid free on the earth, sprayed with the atomizer, and then examined after several days' maintenance in suitably damp air. From all parts, from the apex to the root node, pieces of the epidermis were removed carefully and their surface examined for places of penetration. These were not to be found until the third day and were to be seen with most certainty on the fourth day; later they became gradually obscure. The spots at once attracted attention by a distinct hole in the epidermis. Beneath and inward from this hole, which was often of considerable size, extended always the intruded germ tube which had already grown crosswise through the superficial cell layers and disappeared with its apex in the deeper tissues. The influence of the nutrient material inside the cells of the host plant produced a marked effect on the germ tubes. The tubes here increased visibly in thickness and in vigorous appearance, and already in the deeper optical sections showed branches, which only very seldom appeared in germinations of the conidia in exhausted nutrient solutions.

In favorable preparations portions of the surface were found which appeared as if riddled by drill-holes and were completely permeated by the numerous ingrown germ tubes to a degree not possible to be observed, even approximately, with infective material previously employed. The more recent the places of penetration, the easier it was to see the superficial conidia in direct connection, through the epidermal opening, with the germ tube which had penetrated into the surface cells. After a time this picture lost in distinctness, in proportion as all parts of the fungous germ lying on the outside became empty and transparent and only the penetrated fungous thread bore contents. Still later the hole at the place of penetration disappeared and the germ threads in the outer cells lying near the place of penetration were transformed into delicate, empty threads, still to be recognized as fungous threads, only by the deeper union with normal portions of the tubes. I am inclined to believe that these rapid changes of the penetrated fungous threads take place because of the further growth and consequent stretching of the tissue of the seedlings, which were always infected in their earliest stages, long before they were full grown, and consequently before their

individual parts had reached full size. The fungus germs can follow this stretching of the tissue of the host plant only at their extremities, not in the remoter, older parts, which are incapable of intercalary growth, and which, consequently, being subject to strain, must be obliterated by being drawn out into threads.

Even in the next series of experiments in which older plants were infected; that is, somewhat older seedlings in which the sheath leaf was over a half inch long, but not yet broken through, the places of penetration occurred more rarely, and where they were to be seen many of the penetrated germ tubes had ceased to grow in the outer cell layers. They then exhibited an entirely different appearance, viz, a strong swelling of the membranes, which was often associated with a yellowish color. These objects had an unmistakable likeness to Wolff's drawings of the penetration spots, which the author has described as forming a cellulose sheath around the penetrating germ tubes. I have never seen such a sheath in normal cases of penetration and I consider it quite probable that Wolff only saw imperfect spots of penetration, with swollen germ tubes which he mistook for cellulose sheaths, because he confined his inflections solely to the sheath leaf in which, in somewhat older stages, the penetrated germ tube can not push in any further. (Wolff, *Brand des Getreides*, Halle, 1874.)

In order to follow up these observations I made repeated infection experiments with seedlings in which the sheath leaf was nearly full grown and was already broken through for half an inch by the following leaves. Here from the root node to the uppermost point I found no longer any normal spots of penetration. Very rarely a thread was found which had pushed through the two outer cell layers, then ceased its penetration and slowly perished with swelling of its membrane. At the same time there lay upon the surface hundreds of germinated conidia which could no longer penetrate, because the epidermis, fully formed in the meantime, was no longer permeable. The seedlings, therefore, in this stage of development already behaved toward the fungous germs exactly as do all parts of fully developed plants, into which, as is well known, the threads can not penetrate and in which they can not grow further.

Up to this point of the investigation, therefore, my observations confirmed, with some additions and amplifications, the earlier results of Kühn and some statements of Wolff. Nevertheless, it would appear to me that they only partially exhaust the question as to the place of penetration of the smut germ into the host plant, and that even the new proof material which supported the old idea hitherto generally accepted, that the smut germs must penetrate into the young seedlings in order later to produce smut in the full grown plants, is still insufficient and can not well be regarded as definitely concluding the investigation. For why should the penetration occur only in the young seedling which possesses no other disposition for it except the immaturity

of its tissues, which allows the penetration of the germ? Do not all incipient tissues of the growing tip of full-grown plants likewise exhibit this immature condition?

With our ordinary cereals further experiments did not, indeed, appear to be practicable on account of their small size. The growing tips of oats, barley, wheat, etc., are too small; it is here scarcely possible to bring the fungous germ into the still closed parts of the bud; the young ovaries are also too minute to work on with sufficient clearness of view. But I will nevertheless add that the penetration of fungous germs which I had here introduced into the heart of the growing point by means of the long drawn out point of a spraying flask, was established by direct observation and the threads of the penetrated germs could be seen in the leaves.

But the long series of experiments which I conducted with the larger cereals, corn and sorghum (*Hirse*), proved this much more convincingly. Here the tip is more open. The unexpanded leaves of the bud, folded one within another, open in the form of a large cornet into which we can spray with the syringe flask unlimited quantities of the nutrient solutions containing sprout conidia. These soak down deep between the closed leaves, and in corn, can even reach the growing tip itself with its young staminate panicle, in case the latter, in a somewhat advanced stage of development, has already pushed upward far enough in the bud. Furthermore, in corn the large adventive incipient roots on the lower part of the axis, and the pistillate spikes, particularly, which appear later upon the fully developed axis as sprouts in the leaf axils, offer excellent places of attack. Of course these experiments had to be made on large plants, or, in case of the infection of pistillate spikes, on nearly full grown ones, *in the open air*, where any other protection than a temporary covering with large straw mats was no longer possible.

In order, first, to consider the experiments with sorghum and *Ustilago cruenta*, its associated smut, I will add that I have infected in the heart more than 600 plants from 1 to 3 feet high, by simple injection of the fluid containing the sprout conidia. After four days the further developed portions of the growing point, in so far as they had come into direct contact with the infective fluid, appeared somewhat yellow. Upon superficial sections, the picture of the penetration of the fungous germs was a very clear one. The whole surface was covered with holes, from which big and luxuriant tubes extended into the inner parts of the young leaves, while through their influence was brought about obviously a faint yellowing, and later a more or less distinct wrinkling and shriveling of the attacked leaves. In thin cross-sections were to be found dozens of penetration spots cut through accidentally, while the fungous tubes grew through the entire tissue of the young leaves. That in this case only the young leaves were accessible to the fungous germs was shown on the older portions of the other leaves, which, though

richly covered with germinating conidia, did not show a single penetration spot.

The experiments with corn and corn smut were carried on still more comprehensively. Infections in the heart were first made on young plants about 6 inches high and showing an open apex, up to those of more than 2 feet in height. The appearances of penetrations were uniformly observed in all parts of the young leaves and young axes, in just the same manner except that on account of the size of the corn plants they were yet more distinct than in the sorghum. All the young leaves of the bud, and the still short and unexpanded parts of the axis lying between, were susceptible to penetration, as well as the tips of the axes with the staminate panicles, when the latter were reached by the spraying of the infective fluid. The penetrations also ceased here only when all parts of the bud passed from immaturity to full development. Concerning the adventive roots, and also the side sprouts of the pistillate spikes, which appear later and were infected in the bud, I can assert exactly the same thing as for the buds of the main axis; and, finally, I will state merely for sake of completeness, that also the scattering young hairs on the leaves, which are incipient in the very young leaves, are readily attacked by the fungous germs. Penetration spots were to be seen on these with especial distinctness.

After all possible places of attack by the smut germs have been discovered, there now remains to be added the results which were obtained in the subsequent production of smut upon the proper host plants with the specified smut fungi, by means of the various sorts of infection. This is done for the purpose of arriving at such conclusions as may be drawn with scientific authority in regard to the susceptibility of the host plants used in our experiments to smut diseases at different ages and stages of development, and on the appearance and spread of such diseases.

A. I begin with *Ustilago carbo*, the notorious dusty smut which destroys the fruit of oats, barley, wheat, etc. The smut spores germinate easily and produce sprout conidia in endless generations in nutrient solutions. In mass, the sprout conidia have a hyaline appearance. Their membranes become a little slimy on the outside, so that the germs can not lie together closely, but often form loosely connected heaps, which can again be easily dispersed in fluids.

The infections by dusty smut (*Flugbrand*) were carried on with barley and oats at the same time, and altogether considerably over one hundred series of experiments were made. In order to exclude sources of error, sowings of the uninfected grains were made for comparison, concerning which I will state, in brief, that they brought forth sound culms and fruit, only showing one smutty plant in two cases.

I. For the first series of experiments the grains were chosen particularly in the earliest stage of germination, where the rootlets had already come forth and the plumule was just visible. The tiny plants were placed upon the earth uncovered and were sprinkled all over with sprout

conidia from the atomizer. The culture remained about ten days in a room at 10° C., under cover in the tin boxes previously described and then the plants were set out in the field.

In ten experiments with oats, always with a sowing of 100 grains, the result was on an average 17 to 20 per cent. of smutty panicles. The infected barley remained entirely sound.

II. In the following series of experiments the grains which barely showed rootlets were placed on the earth and so covered with a thin layer of soil, at most ½cm. thick, that only the emerging points of the seedlings were exposed and were infected by means of the atomizer, consequently the infection only reached the sheath leaf. The shoots were infected in the youngest stage when they had pushed out of the earth about ½cm.

In seven experiments with oats, each of 100 grains, the result was not more than 5 per cent. of smutty plants. The barley remained entirely sound.

III. The infection was made as in I on uncovered plants, the shoots of which were about 1½–2cm long, but did not yet show any opened sheath leaf.

Here in eight experiments with oats the result fell back to 2 per cent. of smutty plants; barley sound.

IV. Infection as in II, the sheath leaf only infected, the remaining parts of the seedlings covered with soil, but the shoot of the same length as in III.

In three experiments with oats there was 1 per cent. of smutty plants; in two experiments none were obtained: barley sound.

V. Infection of uncovered seedlings with sheath leaf already pushed through.

In two experiments with oats the result was 1 per cent. of smutty plants, in two others, none; barley sound.

VI. Experiments with infected soil in which the unsprouted grains were sown.

In five experiments with oats the result amounted 4 to 5 per cent. of smutty plants; barley sound.

VII. Experiments with an abundantly infected mixture of soil and fresh horse dung, in which the unsprouted grains were sowed.

Here in three experiments with oats the result rose to 40 to 46 per cent.; in three additional experiments, which were not conducted in a cool room, there was 27 to 30 per cent. of smut; barley again entirely sound.

VIII. Experiments with conidia, which had been cultivated ten months, generation after generation, in nutrient solutions, and which ceased to grow out into threads after the exhaustion of the solutions, infection of young seedlings lying uncovered on the earth in first stage of germination, as in I.

The result was negative. In two series of experiments there was in

one case 1 per cent., in the other 2 per cent. of smutty plants; in two additional series no smutty plants; barley sound.

IX. Experiments with larger plants by external infection and by infection in the heart of the growing tip, were wholly without result.

The final result of the experiments with oats may be summed up as follows: The infection most productive of results is upon the barely germinating young seedlings, just as it was previously stated by Kühn.

The exclusive infection of the sheath leaf is fruitful, as a rule, only in the youngest stages of the same. The infection is without result as soon as the inner leaves have pushed through the sheath leaf more than 1cm.; from this point on the plants are proof against the fungous germ. By the use of nutrient substrata for the conidia sproutings, consequently by means of earth treated to fresh horse dung, the infection of the young seedlings will be greatly increased and the spread of the smut very materially promoted,* corresponding to the experience of husbandmen in the use of fresh dung in the field. Smut germs, which have lived too long and too exclusively outside of the host plant and multiplied in the form of sprout conidia, lose their infective power conjointly with the ability to throw out germ tubes.

But how are the negative results of the experiments to be interpreted? *First*, how is it to be explained that even in the most favorable cases only a large per cent. of the experimental plants become smutty and not all which were infected? And, *second*, whence comes it that in all experiments with barley in not one single case did a plant become smutty?

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* The influence of fresh dung on the production of grain smuts diminishes quickly with the age of the dung, because the conidia germinated in it perish, and in old rotten dung the smut spores develop imperfectly or not at all. The less wet the dung the more slowly decay takes place, and the longer the smut germs can maintain themselves in it.

In the dung of horses, and of swine also, are to be found many oat and barley grains which have not been digested and which subsequently germinate in the dung. Many times by the hundred in root fields I have come across such germinated barley grains, accidentally transported into the field with the fresh swine dung, and have found that for the most part they bring forth smutty spikes. This bears most striking witness to the effect of *fresh* dung in the spreading of smut and in the appearance of smut in *freshly manured* fields. In isolated cases, in small fields, I have gathered the smutted spikes in thick bundles, and have found that out of 100 barley plants were to be found only 10 to 15 sound spikes. It need not be said that in these cases I have each time inquired very exactly and particularly concerning the way of manuring.

PRELIMINARY NOTES ON A NEW AND DESTRUCTIVE OAT DISEASE.

BY B. T. GALLOWAY AND E. A. SOUTHWORTH.

During the months of May and June we received repeated complaints and inquiries concerning a mysterious oat disease which then threatened to destroy the entire crop of the eastern and central States.

During the month of May, when the oats were from 6 inches to a foot in height, the leaves suddenly began to turn brown and die at the tips. The lower leaves were attacked first and the brown color soon extended their entire length. In a very short time all the leaves were dead, or partially brown, and the prospects were that the plants would die and the oat crop be a total failure. About the middle of June, however, the fields began to revive, the oats put out some few fresh green leaves, most of them headed out, and by the first of July many of the fields appeared in a fair condition on superficial observation. In reality, however, the losses from the disease will amount to from 35 to 75 per cent. of the crop, according to the locality. Very discouraging losses are reported from the State of Pennsylvania, where there is probably not a healthy oat field to be found. Kentucky and Tennessee have suffered even more, their present averages as reported to the Statistical Division being the lowest ever reported from any State for a staple crop.

The disease extends from New England to Georgia, and from the Atlantic coast as far west as Indiana and Illinois. It is not present in Michigan. All the agents for the Statistical Division agree in ascribing the cause of this remarkable decline in the oat crop to the same thing, namely, a "blight" or "rust" which struck the fields in May.

The disease prevented the oats from stooling well, and it frequently happened that all the shoots but the main one of a stool were killed. As a result the oats are very thin, and in riding along by a field even at a considerable distance one can see to the ground between the drill rows when the oats are in full head. Besides this the losses are augmented by the fact that the amount of green foliage which developed after the attack was not sufficient to produce a strong growth of the surviving stalks, nor to supply material for a good-sized head; the straw is therefore short and light and the heads small. The heads do not seem to be well filled, and threshing will probably reveal a lighter yield than farmers themselves expect.

Such a universal disease can be attributed to no deterioration of soil or lack of cultivation, although there is no doubt that good cultivation will produce better oats than poor, even when they are diseased. The disease has attacked oats on the best as well as on the poorest soils, fields that were fertilized as well as those that were not. The oats are best, however, in level well cultivated and well drained fields, while they are poorest in low, wet spots and on hillsides and other

places where the soil is thin. In such places they are too short to be harvested.

A very careful study of the plants has been made in the field and laboratory, but nothing in the way of a fungous or animal parasite that could cause the trouble has been found. From the nature of the disease our attention has been directed mainly to a study of it from a bacterial standpoint. Bacteria have been found in every specimen examined. Nearly 200 cultures have been made in at least a dozen different media and all have yielded two germs, one of which is exceedingly abundant. In nearly 50 cases the disease has been produced in young pot-grown plants by inoculating from direct material. Inoculations of young plants with pure cultures are now under way and it is hoped that some definite results will soon be obtained from this source.*

There is still a possibility that although the disease may be caused by bacteria they are dependent upon certain conditions of the atmosphere for their development, and need not be feared another year. Experiments to settle this question are also under way.

COPPER-SODA AND COPPER-GYPSUM AS REMEDIES FOR GRAPE MILDEW.

By J. Nessler.

(Translated from Biedermann's Centrall-Blatt for April, 1890, by Gerald McCarthy, N. C. Experiment Station.)

For several years preparations of copper-soda and copper-lime have been employed for mildew of the grape with good success. Neither of these preparations do any injury to the sensitive parts of the vine. The copper-soda mixture neither clogs the openings of the sprayer nor interrupts the spray by foaming; moreover, it sticks to the leaves very well. With this mixture the granular deposit is formed less rapidly the first day, but after that more rapidly than is the case with the copper-lime mixture. Sulphate of copper is decomposed equally well by soda and by lime. The granular deposit takes place sooner or later, according to the method of preparing the mixtures. Once formed, the pulverulent mass returns to its former state very quickly after being stirred, and on this account it is liable to clog the opening of the sprayer. More particularly is this the case when the lime used is not very finely divided or the copper solution is not sufficiently diluted. One should therefore use in mixing only a perfectly homogeneous lumpless lime-cream and copper solution so dilute that little or no additional water

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* Since writing this the disease has been produced in fifty or more cases by inoculating with the more abundant organism. Five days after inoculating, the characteristic discolorations appeared, and cultures made from these have yielded the typical organism in a nearly pure condition.

need be added before using. Neither mixture should be kept more than one day before being used. The lime gradually precipitates the copper in needle-shaped and granular particles, which very quickly clog the spraying-nozzle. The copper-soda solution after a short time becomes wholly unserviceable on account of the granular deposit. The more or less rapid formation of the deposit depends on the strength of the solution in soda. If, for example, one uses 4½ pounds sulphate of copper and 5¾ pounds of soda, the deposit takes place in eight or ten hours, whereas by using only 5 pounds of soda the solution remains serviceable for twenty-four hours or longer.

In using the copper-lime and copper-soda preparations one should observe the following rules:

(1) The lime must be reduced to a homogeneous lumpless cream.

(2) Both the lime-cream and soda solution must be added only to a very dilute solution of copper sulphate. Indeed this should be so dilute that no subsequent addition of water will be necessary.

(3) Although a larger amount of lime than is necessary may be added without injury to the foliage of the plants, yet according to the quantity of the lime used will be the rapidity with which the pulverulent precipitate is formed. Any surplus of soda will injure the foliage.

(4) The mixture must not be stored, but used immediately after it is prepared.

If one has water handy to the field it may be more convenient and expeditious to prepare at the house strong simple solutions of copper sulphate and soda, and dilute them afterwards in the field. One may, for example, wet 2 pounds 3 ounces copper sulphate with 1¼ gallon of water and 2 pounds 9 ounces soda with the same quantity of water, and for this purpose hot water is the best. Twenty-six ounces of burnt lime or 5½ pounds of air-slaked lime will produce 1¼ gallon of lime-cream. For the production of the final mixtures dilute 2½ gallons of the copper solution to 26 gallons and add 2½ gallons of the soda solution or the same quantity of the lime-cream. Weak mixtures act about as well as strong ones, and instead of 4¼ pounds copper sulphate, one may use only 2 pounds 3 ounces. In place of 5 pounds of soda, 2 pounds 9 ounces may be used. But where the weaker mixtures are employed, it is recommended to spray somewhat more copiously.

The author has also experimented with a dry powder composed of 10 parts copper sulphate, 10 parts burnt lime, and 100 parts calcined gypsum.

Spraying with liquids is preferable to dusting with powders, because in liquid form the copper is more divided and sticks longer to the leaves; the effect being therefore more permanent. On the other hand the powder is very convenient in cases where an effective spraying apparatus is wanting and in situations where water is difficult to procure. Moreover the powder can be applied by women; the liquids can not.

NOTE ON A MINNESOTA SPECIES OF ISARIA AND AN ATTENDANT PACHYBASIUM.

By Conway MacMillan.

Early in April Mr. E. P. Sheldon found on the river bank below St. Anthony's Falls, Minn., a pupa of Orgyia leucostigma, commonly known as the Tussock moth, which was covered with a growth of *Isaria*. The fungus does not correspond to any described species in all its characteristics, though I have determined it provisionally as *Isaria sphingum*, Schw., which is the conidial form of *Cordyceps sphingum*, (Tul.). The description of the Minnesota form is appended:

Stromata gregarious; 1½ to 3 centimeters high, ½ millimeter thick, and slightly subclavate, arising from a pulverulent-granulose, yellowish mycelium, conidial area but slightly thickened, hyphæ 4μ in thickness, indistinctly yellowish, conidia very minute, ovoid, 1½–2 by ½–1½μ; hyaline, deciduous.

This does not coincide exactly with the description of *Isaria sphingum*, Schw., given in Saccardo's *Sylloge Fungorum*, but in the genus *Isaria*, and throughout many of its allies exact descriptions are not attainable, owing to the failure of the older mycologists to measure hyphæ and spores as well as stromata and conidial areas.

An effort to cultivate this species of *Isaria* was made.

Portions of conidial areas were removed with sterilized forceps, and were then placed, with every precaution, in gelatine culture tubes. Some of those, prepared by Dr. George Grübler, of Leipsig, happened to be at hand and were chosen for three cultures. Repeated experiments showed that, together with adventitious forms—*Macrosporium* in one case and *Piptocephalis* in another—a very peculiar plant, clearly of the genus *Pachybasium*, Sacc.—was constantly developed in the gelatine tubes. This *Pachybasium*, distinguished by its bottle-shaped (*ampulliform*) basidia, whorled along the fertile hyphæ, as in *Verticillium*, Nees., is possibly *P. hamatum*, (Bon.) Sacc., described in the *Sylloge Fungorum* Vol. IV, pp. 149, 150. Since, however, the Saccardian description lacks measurements, a description is appended.

Forming minute yellowish patches on gelatine, becoming grayish or greenish-white, fertile hyphæ 3½–4 μ. in thickness, 40–90 μ. in length; ascending with whorls of basidia, either directly attached or with secondary branches interpolated; basidia shortly ampulliform, necks constricted, conidia ovoid 1½–2 by ½–1½ μ., clinging persistently to the basidia.

It will be seen that measurements of the spores and hyphæ of this *Pachybasium* correspond exactly with those given above for the *Isaria*, and this fact, together with the appearance of the former so uniformly in connection with the latter, might tend to give the impression that the two genera are pleomorphous and that in *Pachybasium* we have another step in the life history of *Cordyceps*. It is well known that

Isaria gives rise to peculiar forms in gelatine cultures; for example, according to Alfred Giard, reported in the JOURNAL OF MYCOLOGY, Vol. V., p. 174, *Isaria destructor* assumes the form of *Coremium*. *Coremium* is, however, a genus of *Stilbeæ* very close to *Isaria*, while *Pachybasium* is in the *Mucedineæ*. By the plate-culture methods it is hoped that absolutely pure cultures of the *Isaria* may be obtained, and if there is this genetic connection between *Pachybasium* and *Isaria* it may then become capable of demonstration. The preceding note is intended simply to direct attention to the fact that *Pachybasium* has been distinguished in American habitat, and that it may be looked for in connection with *Isaria sphingum*, Schw. on gelatine cultures of the latter form.

UNIVERSITY OF MINNESOTA.

A FEW NEW FUNGI.

BY J. B. ELLIS AND S. M. TRACY.

PHYLLACHORA STENOSTOMA, *n. s.* On leaf of *Panicum brizanthemum* from Africa. Com. Prof. S. M. Tracy. No. 501. Stromata innate, only slightly prominent, black, rather indefinitely limited, subelongated, 1–2 millimeters long, punctate from the slightly prominent hysteriiform ostiola. Ascigerous cavities small, subglobose, numerous. Asci subfasciculate, sessile, oblong cylindrical, 40–45 by 7–8μ. Sporidia biseriate, oblong, 1-septate and slightly constricted at the septum, yellow-brown, 12–15 by 3–3½μ. Bears a general resemblance to *P. graminis*, but less prominent, sporidia different besides in the narrowly compressed ostilum which resembles a minute *Hysterium*.

FUSARIUM CELTIDIS, *n. s.* On fruit of *Celtis occidentalis*, Starkville, Miss., May, 1890, Tracy, 1333. Sporodochia scattered, erumpent, pulvinate, pale orange, ¼–1 millimeter in diameter. Basidia subfasciculately branched above, branches erect, 40–60 by 4μ, septate. Conidia fusoid, nearly straight, only the obtusely pointed ends slightly curved, 5 septate, 40–60 by 4–5μ.

CLADOSPORIUM VELUTINUM, *n. s.* On *Phalaris Canariensis*, Starkville, Miss., March, 1890. Forming velutinous, olive-brown patches ½–1 centimeter long, or by confluence longer, slightly thickening and distorting the leaf; hyphæ erect, simple, septate, subundulate, pale brown, 50–75 by 4–5μ; condia terminal, 8–20 by 4–5μ, 1–3-septate, subhyaline, the shorter ones elliptical, the longer ones oblong or cylindrical.

PUCCINIA APOCRYPTA, *n. s.* On *Asprella Hystrix*, Cañon City, Colo., Tracy, August, 1887. Hypophyllous, sori oval or oblong, occupying the entire under surface of the lower leaves and remaining covered indefinitely by the epidermis; uredospores oval, epispore thin, minutely

roughened, 20–22 by 23–26μ; teleutospores clavate or oblong, not constricted, thickened above, usually truncate with a broad flat apex but often pointed or irregular, narrowed below, smooth, 14–18 by 42–55μ; pedicel very short. Allied to *P. coronata*, Cda., but the terminal processes are either wanting or only rudimentary.

UREDO PERIDERMIOSPORA, *n. s.* On *Spartina glabra*, Ocean Springs, Miss., Tracy, September, 1889. Epiphyllous, sori linear, near the base of the leaf, long covered by the remains of the ruptured epidermis; spores bright red, pyriform, echinulate, much thickened at the apex, 19–22 by 36–45μ; pedicel short but distinct.

UREDO NYSSEÆ, *n. s.* On *Nyssa capitata*, Jackson, Miss., Tracy, November, 1888. Hypophyllous, sori minute and scattered over the entire under surface of the leaf, but not confluent; spores globose to pyriform, epispore thin, minutely echinulate, 12–15 by 15–30μ.

USTILAGO BUCHLOËS, *n. s.* On leaves of *Buchloë dactyloides*, Cooledge, New Mexico, June, 1887. Sori cylindrical, mostly about 1 centimeter long and 2 millimeters thick, covered by a thin gray membrane and filled with the black, subglobose, very minutely echinulate-roughened spores, 12–15μ in diameter. The sori occur on either side of the leaf, mostly near the tip, and resemble miniature sausages; sometimes two being found exactly opposite each other on the same leaf.

CINTRACTIA AVENÆ, *n. s.* On *Avena elatior*, Starkville, Miss., July, 1889. Transforming the ovaries into a compact black mass about as large as a small shot, made up of compact masses of subglobose spores 5–6μ in diameter, hyaline at first, brown at maturity; epispore smooth and comparatively thin.

SOROSPORIUM GRANULOSUM, *n. s.* On *Stipa viridula*, Trinidad, Colo., Tracy, June, 1887. Involving the entire flower-spike, which becomes so aborted that it barely opens the sheath of the upper leaf; spore masses globose or irregular, 50–75μ in diameter, composed of 20–50 smooth, globose, or by pressure irregular spores, 14–16μ.

USTILAGO HILARIÆ, *n. s.* On *Hilaria Jamesii*, Albuquerque, N. Mex., Tracy, June, 1887. Involving the entire flower-spike, and forming a compact cylindrical or ovate mass ½–1 by ¼ centimeter, inclosed in a thin gray membrane; spores oval, brown, sharply echinulate, 10–14 by 12–15μ, or globose; 12–12μ. *U. cylindrica*, Pk. has smaller spores.

USTILAGO OXALIDIS, *n. s.*, N. A. F. 2424. Starkville, Miss., Tracy, May, 1888. In ovaries of *Oxalis stricta*, filling the entire ovary with a mass of reddish-brown spores; spores globose, 10–12μ; epispore rather thick, sharply echinulate.

COMBATING THE POTATO BLIGHT.

By J. H. Bünzli.

[Translated from Biedermann's Centrall-Blatt for April, 1890, by Gerald McCarthy, N. C. Experiment Station.]

The use of preparations of copper sulphate as a means of checking the potato blight has in practice proved a brilliant success. The experiments made by the author in the years 1887 and 1888 indicate clearly that potato-growers should not begrudge the small expense of applying the remedies if they aim at extensive cultivation of the potato plant. The fungicides employed in the above mentioned years were as follows:

(1) Bordeaux mixture: 17 pounds 10 ounces copper sulphate; 33 pounds lime; 34 gallons water.

(2) Copper-soda solution: (*a*), 2 pounds 3 ounces copper sulphate; 3 pounds 5 ounces soda; 26 gallons water; (*b*), 4 pounds 6 ounces copper sulphate; 6 pounds 10 ounces soda; 26 gallons water.

(3) Azurin (prepared after Morgenthaler's formula).

(4) Poudre Coignet.

For the first treatment, made before the flowers fell, the author used the preparations 1, 2*a*, 3, and 4, there being one plot for each solution. The plots were so arranged as to give to each the same exposure, fertility and texture of soil. Soon after the observation was made that wherever the azurin was used the result was unsatisfactory. The Bordeaux mixture gave quick results, but its manipulation was difficult. Under the circumstances the author concluded to use a stronger solution of No. 2*a*, and at the second spraying of the vines employed solution No. 2*b*. The Poudre Coignet was laid aside, as it was found to be of no service whatever, and besides badly burned the leaves and stems.

Plot 1 was sprayed the second time with a dilute solution of the Bordeaux mixture, viz: 6 pounds 10 ounces copper sulphate, 6 pounds 10 ounces lime, and 26 gallons of water. Plot 3 received azurin again. This second application was given at the beginning of August, but soon afterward, in spite of the Azurin, the plot was found badly affected. Part of the plot was immediately resprayed with solution No. 2*b*, but with only partial success, because the blight had already secured such an advantage that it could not be dislodged. Nevertheless the supplementary treatment showed some effect. In each treatment the author aimed to use upon one acre (*juchart*) 53 gallons to 79 gallons of fluid, put on with an efficient sprayer so that the liquids were well distributed on both sides of the leaves, insuring more complete adhesion and less risk that the material would be all washed off by the first rain.

Although the weather was copiously moist, with the inevitable result of dissolving away the protective materials used, the plots treated with the Bordeaux mixture and copper-soda solutions were still green at the

beginning of September, while on all the other plots the vines were completely dried up. Where the soda solution had been used the leaves and stems appeared large and fine; where the copper-lime mixture had been used the leaves and stems were considerably smaller.

The harvest gave the following results:

Plot 1 (Bordeaux mixtures).—Three-fourths average yield of sound tubers. The tubers were small but solid. Few were diseased.

Plot 2 (Copper-soda solutions).—Full average yield of sound tubers, besides some diseased ones. None were rotten.

Plots 3 *and* 4 (Azurin and Poudre Coignet).—One-fourth an average yield. On Plot 3, where the solution 2*b* had been used, the harvest was two-fifths of a full yield.

The author's experience leads to the conclusion that potato fields should be sprayed twice—the first spraying about July 1, the second about August 15. For early varieties the treatments should be earlier. The author especially recommends, in the order given, solution 2*b*, and the Bordeaux mixture reduced to 6 pounds 10 ounces copper sulphate, 6 pounds 10 ounces lime, and 26 gallons of water.

MUCRONOPORUS ANDERSONI, *n. s.*

BY J. B. ELLIS AND BENJAMIN M. EVERHART.

Under the bark of an oak log, Newfield, N. J., April, 1890. Found by Mr. F. W. Anderson, to whom the species is dedicated. Effused, immarginate, entirely concealed by the bark which is finally thrown off, 20 or more centimeters long and 5 centimeters broad. Pores about half a centimeter long and $\frac{1}{3}$ millimeter in diameter, marginal ones broader and shorter, margins acute, nearly round, chestnut color, stained yellowish by the sulphur-yellow spores, (5–6 by 4–5μ), which are discharged in great abundance, coloring the inner surface of the bark and escaping through the cracks in the bark in such abundance as to cover the leaves and other things near with a bright sulphur-yellow coating. Spines not very abundant, conical at first, then elongated to 15–25μ long by 6–7μ thick.

The subiculum from which the pores arise is very thin, so that they penetrate almost to the wood. The hymenium when fresh is very soft and pliable and the walls of the pores contract in drying, so that they are often torn from their attachment below and the hymenium becomes very much cracked.

The yellow coating of spores discharged on the bark constitutes the so-called "*Chromosporium pactolinum*, Cke. & Hark." (*C. vitellinum*, S. & E. in Syll.,—*C. Isabellinum*, in N. A. F., 1391.)

INDEX TO NORTH AMERICAN MYCOLOGICAL LITERATURE.

By David G. Fairchild.

15. Bailey, L. H. **Damping off.** American Garden, Vol. XI, No. VI. June, 1890, p. 348. Thinks disease due to "potting-bed fungus," and recommends preventive remedies.
16. Benton, L. E. **A Japanese plum disease** (with figure). Pacific Rural Press, May 17, 1890, Vol. XXXIX, No. 20, p. 505. *Taphrina pruni*, Tul., on imported species of plum.
17. Bessey, C. E. **The diseases of farm and garden crops.** No. I. Announces series giving list of diseases to be spoken of. Nebraska Farmer, January 30, 1890, Vol. XIV, No. 5, whole No. 402, p. 89.
18. ——— No. II. **Black knot** [*Plowrightia morbosa*, (Schw.) Sacc.]. *Ibid.*, February 13, 1890, Vol. XIV, No. 7, whole No. 404, p. 129. Gives popular life history with recommendation to cut and burn diseased parts.
19. ——— No. III. **Stinking smut** [*Tilletia fœtens*, (B. & C.) Trel.]. *Ibid.*, February 13, 1890, Vol. XIV, No. 7, whole No. 404, p. 130. Defines "smut," gives means of propagation, and recommends blue-vitriol solution for seed-wheat.
20. ——— No. IV. **Grain smut** [*Ustilago segetum*, (Bull.) Dit.]. *Ibid.*, February 20, 1890, Vol. XIV, No. 8, whole No. 405, p. 151. Recommends rotation in crops to prevent continuance of disease.
21. ——— No. V. **Corn smut** [*Ustilago maydis*, (DC.) Corda]. *Ibid.*, February 27, 1890, Vol. XVI, No. 9, whole No. 406, p. 165. Notes injury from disease and danger of using manure from animals fed with smutty corn.
22. ——— No. VI. **Sorghum smut** [*Ustilago sorghi*, (Link.) Pass]. *Ibid.*, Vol. XIV, No. 10, whole No. 407, p. 189, March 6, 1890. Notices appearance of smut on Mill's maize in Nebraska and Wisconsin; recommends bath of blue-vitriol water for seed.
23. ——— No. VII. **The strawberry leaf-spot** (*Ramularia Tulasnei*, Sacc.). *Ibid.*, March 15, 1890, Vol. XIV, No. 11, whole No. 408, p. 209. Discusses removal of all leaves in fall, as preventive measure.
24. ——— No. VIII. **Grain rust** (*Puccinia graminis*, Pers., and other species). *Ibid.*, March 27, 1890, Vol. XIV, No. 13, whole No 410, p. 250. Gives life history with well-known means of preventing spread.
25. ——— No. IX. **The rust of the Indian corn** (*Puccinia sorghi*, Schw.). *Ibid.*, April 10, 1890, Vol. XIV, No. 15, whole No. 412, p. 293. Recommends all uncut fodder to be burned, thus preventing wintering of fungus.
26. ——— No. X. **The raspberry stem fungus.** *Ibid.*, April 24, 1890, Vol. XIV, No. 17, whole No. 414, p. 333. Refers to destructiveness, with general means of combating the fungus.
27. ——— **Seymour and Earle's economic fungi.** American Naturalist, March, 1890, Vol. XXIV, No. 279, p. 277. Remarks usefulness of the publication.
28. ——— **Ellis' North American fungi.** American Naturalist, March, 1890, Vol. XXIV, No. 279, p. 277. Short comment on quality of the work.
29. Billings, John S. **Some tiny fungi.** Youth's Companion, Vol. 63, No. 20, May 15, 1890, p. 272. Notices bacteria, fermentation, fungus on tomato.
30. Bolley, H. L. **Note on the wheat rust.** Microscopical Journal, March, 1890, Vol. XI, No. 3, p. 59. Discusses question of other host than Barberry for the æcidium of *P. graminis*. Notes possible infection through sporidia or dissemination of early formed uredospores. Expresses opinion that neither *P. rubigo-vera*, (D. C.) Wint., nor *P. graminis*, Pers., are truly perennial. Suggests questions in regard to winter life and identity of *P. rubigo vera* with European species.

31. CHESTER, F. D. **A botanical description of the black-rot of the grape** (with figures from Ann. Rept., Section of Vegetable Pathology, 1886). Second Annual Report of Delaware Agricultural Experiment Station, 1889, issued February, 1890. Presents in concise popular form the results of investigations of Section Vegetable Pathology, and others, into life history of *Læstadia Bidwellii*, (Ellis) V. & R.

32. ——— **Peach yellows, culture tests.** *Ibid.*, pp. 92–94. Shows complete failure of attempts to produce bacterial colonies in peach-wood infusions or nutrient gelatine from portions of the inner bark of diseased twigs.

33. ——— **The black-rot of the grape controlled by Bordeaux mixture.** *Ibid.*, pp. 79–87. Offers results of experiments in 1889 on vineyard of 1199 vines, near Smyrna, Del.

34. ——— **Spraying with sulphide of potassium for the scab of the pear.** *Ibid.*, pp. 88–91. Reports successful experiment near Newark, Del., upon the fruit of fourteen pear trees attacked by *Fusicladium pyrinum*, Fckl. Same found in Bull. Del. Ag. Ex. Sta. VIII, March, 1890, p. 11.

35. ——— **Diseases of alfalfa.** *Ibid.*, pp. 94–97. Notices *Phacidium medicaginis*. Lasch., and describes as new *Cercospora helvola*, Sacc., var. *medicaginis*, on *Medicago sativa*, with original figure.

36. CURTISS, GEORGE G. **Treatment of bitter-rot of the apple.** Bull. 11, Sect. Veg. Path., U. S. Dept. Ag., p. 38. Reports successful treatment of *Glœosporium fructigenum*, Berk., with potassium sulphide and ammoniacal copper carbonate solutions. Prefers latter solution.

37. EARLE, F. S. **Experiments with fungicides for plant diseases.** Bull. 11, Sect. Veg. Path., U. S. Dept. Ag., p. 83. Notes injury to peach and plum leaves from Bordeaux mixture applied for rust (*Puccinia pruni*, Pers.).

38. ELLIS, J. B., and EVERHART, B. M. **Notes on a species of Coprinus from Montana** (with Plate IV). The Microscope, May, 1890, Vol. X, No. 5, p. 129. Describes and figures *Coprinus sclerotigenus*, E. & E., as new, from Great Falls, Montana.

39. GALLOWAY, B. T. **Report on the experiments made in 1889 in the treatment of the fungous diseases of plants.** Bull. 11, Department of Agriculture, Section of Vegetable Pathology. Contains reports on diseases of grape, apple, quince, pear, plum, peach, melon, potato, tomato; with reports of Goff, Howell, Holliday, Jaeger, Scribner, Earle, and Pearson, also summary of volunteer reports on treatment of grape diseases, and announcement of new fungicides, translated from Italian of Comes & Deperais.

40. ——— **Notes on the fungus of apple scab.** Bull. No. 59, Mich. Ag. Exp. Sta., April, 1890, p. 27.

41. ——— **Pear leaf blight** (with fig.). Proc. 15th Ann. Meet. Am. Ass'n. of Nurserymen, 1890. Gives description of *Entomosporium maculatum*, Lév., with latest methods of treatment.

42. GOFF, E. S. **Treatment of apple scab** (with Plate I). Bull. 11, Sect. Veg. Path., U. S. Dept. Ag., p. 22. Gives successful results of experiments on twelve trees with potassium sulphide, sodium hyposulphite, Bean's sulphur powder, ammoniacal copper carbonate, and Bean's liquid sulphur preparation. Decides in favor of ammoniacal copper carbonate.

43. ——— **Prevention of apple scab** (with fig.). Bull. 23, Univ. of Wisc., April, 1890. Reports experiments made in connection with Sect. Veg. Path. in 1889. Reported in Bull. 11 of the Section of Vegetable Pathology, Dept. Ag.

44. ——— **Prevention of apple scab**, *Fusicladium dendriticum*, Fckl. The Prairie Farmer, April 19, 1890, Vol. 62, No. 16, p. 246. Describes use of fungicides in treatment of the disease.

45. HALSTED, B. D. **Why not legislate against the black knot.** Garden and Forest, April 16, 1890, Vol. III, No. 112, p. 194. *Plowrightia morbosa*, (Schw.) Sacc. is

45. **Halsted, B. D.—Continued.**
noted as being from its character easily legislated against. Thinks the law should be made to include wild plum and cherry trees.

46. ——— **Anthracnose or blight of the oak.** Garden and Forest, June 18, 1890, Vol III, No. 121, p. 295. The *Glœosporium nervisequum*, (Fckl.) Sacc., attacking *Platanus occidentalis*, described in the Journal of Mycology, Vol. 5, No. II, is found causing great damage to the leaves of white-oak trees near New Brunswick, N. J. It is recommended to cut down the affected trees to check the spread of the disease.

47. ——— **Legislation against fungous diseases.** Garden and Forest, June 25, 1890, Vol. III, No. 122, p. 307. Gives copy of law of New Jersey enacted May 23, 1890, authorizing destruction of all plants which in the opinion of the officers of the State Experiment Station are so diseased as to threaten injury to agricultural interests. Owners of diseased plants to be recompensed by State. Notices, in connection, *Peronospora rubi*, Rabenh., upon cultivated raspberry, as being new to this country.

48. ——— **Nematodes and the oat crop.** Garden and Forest, July 2, 1890, Vol. III, No. 123, p. 319. Notices presence of bacteria in diseased oat plants without determination as to pathogenic nature. The presence of abundant nematodes in the small roots is thought a possible cause. Refers to articles of Comstock, Atkinson, and Neal on nematodes, and mentions possible preventive measures to be taken.

49. ——— **Anthracnose on the maple.** Garden and Forest, July 2, 1890, Vol. III, No. 123, p. 325. Mentions a tree of *Acer rubrum* standing near an oak attacked with *Glœosporium nervisequum*, (Fckl.) Sacc., as having been badly diseased with the same fungus.

50. ——— **Sweet-potato soil-rot and other forms.** Rural New Yorker, April 19, 1890, Vol. XLIX, No. 2099, p. 249. Notices "ground-rot" similar to clover sickness: soft rot due to a *Mucor;* black-rot, stem-rot, and white-rot, giving popular descriptions of the various forms.

51. ——— **Fungi injurious to crops.** Tenth Annual Report New Jersey Ag. Exp. Sta., 1889; published 1890, pp. 231–237. Notices prevalence of and remedies for potato-rot, grape-rot, cranberry gall fungus (*Synchytrium vaccini*, Thomas), cranberry scald, cucumber mildew (*Peronospora cubensis*, B. & C.), sweet-potato rots. The decay of market fruits. *Phyllosticta Halstedii*, Ell., on Lilac, (*Syringa vulgaris*, L.), mentioned as new.

52. ——— **Fungi injurious to horticulture.** Proc. N. J. State Hort. Soc., 15th Ann. Meeting, Dec. 18–19, 1889, published in 1890. Diseases of the following plants are briefly mentioned, with a possible remedy: Apple, pear, quince, peach, plum, cherry, grape, blackberry, raspberry, gooseberry, currant, strawberry, cranberry, Irish potato, sweet potato, egg-plant, tomato, watermelon, squash, cucumber, cabbage, lettuce, onion, carrot, celery, parsnip, beet, salsify, bean, pea, rose, violet, mignonette, and carnation.

53. ——— **Rusts, smuts, ergots, and rots. Some of the diseases that seriously affect field crops, vegetables, and fruits. Remedies that have proved successful.** Address before N. J State Board of Ag., Jan. 31, 1889 (May 26, 1890), Pamph. 8vo., pp. 21. Popular exposition with lists of fungi injurious to New Jersey farm crops, and illustrative plates of *Phytophthora infestans*, DBy., *Claviceps purpurea*, Tul., *Puccinia*, sp., *Tilletia* sp., and *Ustilago* sp.

54. ——— **A new white smut.** Bull. Torrey Botanical Club, April, 1890, Vol. XVII, No. 4, p. 95. Describes *Entyloma Ellisii*, n. s., as infesting the cultivated spinach, *Spinacea oleracea*. Notes *E. linariæ* forma *Veronicæ*, nov. forma, on *Veronica peregrina*, differing sufficiently from that on *Linaria vulgaris* to warrant name. Gives list of *Entylomata* with orders of host plants, showing *Spinacea* to introduce a new host order.

55. HARKNESS, H. W. **Curled leaf.** Zoë, San Francisco, Cal., Vol. I, No. 1, March 1890, pp. 87–88. Remarks on probable identity of disease of leaves of *Æsculus Californica*, with *Ascomyces deformans*, Berk.

56. ——— **The nomenclature of fungi.** Zoë, San Francisco, Cal., Vol. I, No. 2, April, 1890, pp. 49–50. Remarks upon the probable identity of numerous different species described on nearly related hosts, noticing the excellent work of Dr. Farlow's Host Index, and criticising sharply the practice of species-making upon insufficient bases.

57. HARRIS, J. S. **Grape diseases.** Ann. Rep. Minn. State Hort. Soc. for 1889, Vol. XVII, pp. 284–287. Notices *Peronospora viticola*, B. & C., black-rot, white-rot, and bitter-rot; remarks on seriousness of last; gives remedies, referring to Dept. of Agr., Sect. of Veg. Path., Bull. 5.

58. HOLLADAY, A. L **Treatment of grape diseases.** Bull. 11, Sect. Veg. Path., U. S. Dep., Agr., p. 70. *Læstadia Bidwellii*, (Ellis) V. & R., and *Peronospora viticola*, B. & C., treated successfully with copper compounds.

59. HOWELL, A.M. **Report for 1889 in treating diseases of the grape and tomato** (with plates VII and VIII). Bull. 11, Sect. Veg. Path, U. S. Dept. Agr., p. 49. Describes at length course of treatment with Bordeaux mixture for *Læstadia Bidwellii*, (Ellis) V. & R.; and Bordeaux and ammoniacal copper carbonate solutions for tomato-rot (*Macrosporium* sp.).

60. JAEGER, HERMANN. **Treatment of grape diseases.** Bull. 11, Sect. Veg. Path., U. S. Dept. Agr., p. 65. Reports successful treatment of *Coniothyrium diplodiella*, (Speg.) Sacc. *Læstadia Bidwellii*, (Ellis) V. & R. and *Peronospora viticola*, B. & C. in Missouri, with note on presence of black-rot on wild species of *Vitis*.

61. JENNINGS, H. S. **Some parasitic fungi of Texas.** Bull. 9, Texas Agr. Expt. Sta., May, 1890, College Station, Texas. A list with notes on injuriousness. Several provisional new species given without descriptions. *Cercospora sp.* n. s., on *Begonia; Colletotrichium bromi*, n. s., on *Bromus unioloides; Diorchidium boutelouæ* on *Bouteloua racemosa; Ravenelia Texanus*, Ell. & Galw., on *Desmanthus* or *Cassia; Tilletia rugispora*, Ell. & Galw., on *Paspalum plicatulum; Ustilago apiculata*, Ell. & Galw., on *Andropogon saccharoides*.

62. KELLERMAN, W. A. **The hackberry** (with plate). Industrialist, Manhattan, Kans., Vol. XV, No. 26, March 1, 1890, p. 109. Notices disease of hackberry "knot" caused by *Sphærotheca phytoptophila*, Kell. & Swing., and *Phytoptus*, sp., gives distribution.

63. ——— **Prevention of smut.** Industrialist, Manhattan, Kans., Vol. XV, No. 25, February 22, 1890, p. 101. Reports on letter from J. L. Jensen regarding augmentation of crop by hot-water treatment, and method of using said treatment.

64. LATHAM, A. W. **Diseases of the grape-vine in Minnesota.** Ann. Rep. Hort. Soc. Minn. for 1889, Vol. XVII, p. 287. Notices "Greely rot," powdery mildew and downy mildew. Remarks latter to be the only serious disease in the section. Refers to work of Dept. of Agr. on the subject.

65. LOCKWOOD, SAMUEL. **Fungi affecting fishes. An aquarium study. First paper,** *Saprolegnia*, read March 7, 1890 (with plates 22–23). Journal New York Microscopical Society, Vol. VI, No. 3, July, 1890, pp. 67–78. Notices *Saprolegnia ferax* as attacking black sun-fish, spotted sun-fish and a species of pirate perch, in the aquarium. Twenty-four individuals succumbed to attack of fungus in six weeks. Describes and figures fungus, giving life history including formation of oospore; mentions *Dictyuchus* as found in connection with *S. ferax*. Thinks application of carbolic acid impracticable.

66. ——— **Fungi affecting fishes. An aquarium study. Second paper,** *Devœa*, read March 21, 1890 (with plate 24) *Ibid.*, pp. 79–85. Gives description of *Devœa infundibilis*, n. s. attacking and destroying in an aquarium six specimens of *Hippocampus heptagonus*, Rafin., giving abundant figures of fungus, with mode of growth.

67. LONSDALE, EDWIN. Damping off. American Garden, Vol. XI., No. 6; June, 1890, p. 348. Mentions greenhouse methods of treatment.

68. MASSEY, W. F. Damping off. American Garden, Vol. XI, No. VI, June 1890, p. 347. Ventures the opinion that the disease is due to the combined action of algæ and fungi.

69. MAYNARD, S. T. Some observations on peach-yellows (with figures). Bull, No. 8, Mass. Hatch Expt. Sta., April, 1890, pp. 6–12. Discusses symptoms of disease; its relation to food supply, injury by cold, borers, and accident; recommends destruction of all diseased trees.

70. ——— Damping off. American Garden, Vol. XI, No. 6, June, 1890, p. 347. Refers diseases to a fungus and recommends course of treatment.

71. MCBRIDE, T. H. The saprophytic fungi of eastern Iowa (with plates IV and V), Bull. Laboratory of Nat. Hist. of State University of Iowa, Iowa City, Vol. I, Nos. 3–4, June, 1890, pp. 181–195. Continues a descriptive list, with notes on distribution and microscopical characters, begun in Vol. I, No. 1, pp. 30–44. Noticing four species of the series *Hyporhordii*, eight of *Dermini*, ten of *Pratelli*, four of *Coprinarii*, and six species of *Coprinus*. Figures in part *Agaricus campester*, *A. rapidus*, *Russula* sp. *Polyporus lacteus*, *Morchella esculenta* and *Lycoperdon cyathiforme*.

72. ——— Common species of edible fungi. *Ibid.*, p. 196. Describes three species, *Morchella esculenta*, Linn., *Agaricus campestris*, L., and *Lycoperdon cyathiforme*, Bosc., as fit for table use.

73. MCCLUER, G. W. The blight of the sycamore. Garden and Forest, July 21, 1890, Vol. III, No. 123, p. 325. Notices *Glœosporium nervisequum*, (Fckl.) Sacc., as destructive to Sycamore trees at Champaign, Ill., for twenty years; also as found in northern and western Illinois, and in fact throughout the State.

74. MEEHAN, THOMAS. Damping off. American Garden, Vol. XI, No. VI, June 1890, p. 347. Refers diseases to a fungus, gives possible remedies.

75. MORGAN, A. P. North American fungi. Journ. Cincinnati Society of Natural History, Vol. XII, No. 4, January, 1890, p. 163. Third paper. Papers 1 and 2, found in Vol. XI, p. 149, and XII, p. 22 respectively. The *Gastromycetes*, read by title, February 4, 1890, (with Plate XVI).

76. ——— Mycological observations I. Bot. Gaz. Vol. XV., No. 4, April 19, 1890, p. 84. Mentions habitats and peculiarities of *Schizophyllum*, *Menispora*, *Arthrosporium*, *Bactridium*, *Nœmatelia nucleata*, Schw., *Stereum albobadium*, Schw., *Dacrymyces deliquescens*, Bull.

77. PAMMEL, L. H. Some fungous diseases of fruit-trees in Iowa. Abstract from Proceedings of the Iowa Academy of Sciences, 1887-'89. March 10, 1890. Mentions *Entomosporium maculatum*, Lév., as defoliating all young pear-trees with the exception of Chinese variety. Notes its presence on species of *Pyrus*, *Cydonia*, *Mespilus*, and *Cotoneaster*.

78. ——— Diseases of forage plants. Proceedings 16th Ann. Meeting Iowa Improved Stock-Breeders Association, pp. 138–141. *Puccinia graminis*, *P. rubigo-vera*, *Ustilago maydis*, *Tilletia striæformis*, *Claviceps purpurea* are noticed.

79. ——— Beggiatoa alba and the dying of fish in Iowa. Proc. Iowa Acad. Sci., 1887–'89, March 10, 1890. Notices presence of the putrefactive bacterium in waters of State in connection with dead fish.

80. ——— A cherry disease. *Ibid.* Treats of leaf disease caused by *Cylindrosporium padi*, Karst. Discusses synonomy, and refers *Septoria cerasina*, Pk., and *S. pruni*, Ellis, to *C. padi*, Karst. Iowa specimens were found by Mr. Ellis to agree with Karsten's species.

81. ——— Cotton-root rot. Second Annual Report Tex. Ag. Ex. Sta., College Station, Tex., pp. 61–85 (with Plates I–V, figuring *Ozonium auricomum*, Lk., and *Verticillium*). Gives theories and general character of the disease, plants affected by the cotton fungus (*O. zonium auricomum*, Lk.); the fungus on forest and

81. PAMMEL, L. H.—Continued.
apple trees; weeds affected; botanical characters; other fungi on the roots of cotton and sweet potato; the character of the lint of diseased cotton; the seed of diseased cotton; treatment, use of fertilizers and manure; rotation of crops; how and what plants to be used in rotation; treatment of forest and apple trees; also a list of references to articles on the subject.

82. ——— **New lima-bean mildew.** The Orange Judd Farmer, May 10, 1890. Gives popular description of *Phytophthora phaseoli*, Thax.

83. ——— **Onion smut.** Orange Judd Farmer, April 26, 1890. Popular review of report by Roland Thaxter in Annual Report Conn. Ag. Ex. Sta., 1880. *See* 10, I.

84. ——— **Smuts, wheat and oat.** Orange Judd Farmer, March 29, 1890. Popular exposition.

85. PEARSON, A. W. **Notes on strawberry culture.** Garden and Forest, March 19, 1890. Vol. III, No. 108, p. 141. Notices *Sphærella fragariæ*, Sacc., and recommends winter and spring liming. Sodium hyposulphite and potassium sulphide are thought also effective in treatment. Mentions burning with sulphuric acid as effective.

86. ——— **Report of experiments made in 1889 in treatment of fungous diseases of plants.** Bull. 11, Sect. Veg. Path., p. 41. Grape maladies, apple leaf-rust, pear leaf-blight (with Plates V, VI), quince diseases, melon blight, tomato blight, potato blight, strawberry leaf-blight, are treated of and the results of field experiments with fungicides given.

87. ——— **The use of fungicides in the prevention and cure of fungous diseases of plants.** Fifteenth Proceedings N. J. State Hort. Soc., Dec. 18-19, 1890, pp. 163–175. Popular address, giving results of original experiments with numerous diseases of grape, apple, pear, quince, and potato.

88. SCRIBNER, F. L. **Dotted or speckled anthracnose of the vine** (with fig.) Orchard and Garden, April, 1890, Vol. XII, No. 4, p. 82. Discusses disease, external characters, microscopical characters, quoting Viala's opinion that *Anthracnose macula* and *Anthracnose ponctuce* are caused by the same fungus. A wash of 50 per cent. solution of iron sulphate is recommended.

89. ——— **Plum-rot, or the monilia of fruit** (with figs.) Orchard and Garden, May, 1890, Vol. XII, No. 5, p. 103. Notices *Monilia fructigena*, with brief life history, figuring same. Quotes Erwin F. Smith, JOURN. OF MYCOL. 5, III, and discusses treatment with copper carbonate.

90. ——— **Apple scab and its treatment** (with figs.) Orchard and Garden, Vol. XII No. 6, June, 1890, p. 113. Gives distribution and destructiveness, with life history and methods of treatment, of fungus, quoting from Prof. Goff's report, Wis. Ag. Expt. Sta., 1889.

91. ——— **The smut of onions** (with figs.) Orchard and Garden, Vol. XII, No. 6, June, 1890, p. 118. Reviews at length work of Roland Thaxter in Ann. Rep. Conn. Ag. Expt. Sta. for 1889, giving figures redrawn. *See* 10, I.

92. ——— **Apple rust and cedar apples** (with figures taken from Ann. Rep. Sect. Veg. Path. 1888). Orchard and Garden, July, 1890, Vol. XII, No. 7, p. 134. Notices *Rœstelia pirata*, Thax., and *Gymnosporangium macropus*, Link., giving connection and life history, with recommendation to remove cedars from vicinity of orchards, plant resistant varieties of apples, and spray with the Bordeaux mixture.

93. ——— **Treatment of certain fungous diseases of plants.** Special Bulletin, Tenn. Ag. Expt. Sta., May 10, 1890. Gives results of usual methods of treatment for black rot of grapes, apple scab, downy mildew of the vine, brown-rot of grapes; powdery mildew of the grape-vine, gooseberry, rose, and apple; leaf brownness of pear and quince, potato rot, smut of oats and wheat, quoting from Kans. Expt. Sta. Bull. 8, p. 95.

94. ——— **Report on the extent, severity, and treatment of black-rot in northern Ohio in 1889.** Bull. 11, Sect. Veg. Path., U. S. Dept. Ag. Notes diminished parasiticism of *Lastadia Bidwellii*, (Ellis) V. & R., and destructive nature of *Peronospora viticola*, B. & C. in this region.

95. SECTION OF VEGETABLE PATHOLOGY. **Fungoid diseases.** Ann. Rep. State Board of Hort. of California for 1889. Issued 1890. Verbatim extracts from the reports of the section for 1887–'88, treating of *Entomosporium maculatum*, Lév., *Puccinia pruni*, Pers., *Podosphæra oxyacanthæ*, D. C., *Phragmidium mucronatum*, Wint., *Actinonema rosæ*, Lib., *Sphærella fragariæ*, Sacc,

96. SEYMOUR, A. B. **A race of flowerless plants, I.** Fungi—What they are and how they live (with figures). American Garden, February, 1890, Vol. XI, No. II, p. 79. Gives general outline of saprophytic and parasitic fungi, distinguishing the two, with suggestion as to time to apply remedies; figures *Uredo* stage of *Puccinia*; section of *Hymenomycetes* and others.

97. ——— **A race of flowerless plants, II.** The metamorphoses of Fungi—How different forms change into each other (with plate). American Garden, March, 1890, Vol. XI, No. III, p. 135. Notices apple rust (*Rœstelia*) (fig.), Cedar balls (*Gymnosporangium macropus*, Link.) (fig.), wheat rust (fig.) (*Puccinia graminis*, Pers., *P. Rubigo vera* (DC.) Wint., and *P. coronata*, Corda), Black rot (fig.). Refers to system of terminology used by botanists.

98. ——— **A race of flowerless plants, III.** Yeast and Bacteria—Putrefaction and Fermentation—Pear blight, (with figures). American Garden, Vol. XI, No. IV, p. 215, April, 1890. Notices discovery of bacterial diseases in plants by Burrill, with figures of pear blight bacteria and sections of diseased and healthy pear bark.

99. ——— **A race of flowerless plants, IV.** How fungi are dispersed, with hints for the cultivator (with figures after DeBary, Pringsheim, Hine and Brefeld). American Garden, Vol. XI, No. V, May, 1890, pp. 276–278. Notices methods of spore dispersion in *Discomycetes*, *Pilobolus*, *Saprolegnia*, *Phallus*, *Puccinia*, *Claviceps*, *Ustilago*, and hints at general means of preventing spread of diseases.

100. ——— **A race of flowerless plants, V.** How fungi injure plants (with figures.) American Garden, Vol. XI, No. VI, June, 1890, p. 353. Mentions spot diseases of currant leaves; spot disease of mignonette leaves; ergot, pear scab, plum pockets, cedar apples, and corn smut.

101. ——— **Damping off** (with figures). American Garden, Vol. XI, No. VI, June, 1890, p. 349. Refers the disease to *Phytophthora omnivora*, DBy. (or *Pythium omnivora*) and *Phthium DeBaryanum*, Hesse. Thinks the latter most likely the cause of the trouble in America.

102. ——— **Notes on corn smut—a warning.** Cult. and Count. Gent., April 24, 1890, Vol. LV, No. 1943, p. 323. Describes life history of smut, and accounts for increase from year to year by reference to discoveries of Brefeld.

103. SNOW, F. H. **Experiments for the artificial dissemination of a contagious disease among chinch-bugs.** Proceedings nineteenth annual meeting Kansas State Board of Agriculture, pp. 142–144; also transactions Kansas Academy of Science, Vol. XII, Part I, for 1889 (1890), pp. 34–37. Notices *Entomophthora* disease of chinch-bug.

104. TAFT, L. R. **Experiments with remedies for the apple scab** (with plates II, III, and IV). Bull. 11, Sect. Vegt. Path., U. S. Dept. Ag., p. 30. Reports on experiment with twenty trees for disease of *Fusicladium dendriticum*, Fckl., using potassium sulphide, sodium hyposulphite, Bean's sulphur solution, ammoniacal solution of copper carbonate, modified eau celeste. Decides eau celeste and ammoniacal solution most efficient.

105. THAXTER, ROLAND. **Fungicides.** Bull. No. 102, Conn. Ag. Expt. Sta., March, 1890. Formulæ, with new spraying contrivance figured.

106. WEED, C. M. **A season's work among the enemies of the horticulturist** (with plates). Journ. Columbus Hort. Soc., Vol. IV, No. 4, December, 1889, pp. 94–106; extracted, February, 1890. Notices black rot of grape, quince leaf spot (*Morthiera mespili*, Sacc.), apple scab, brown rot of stone fruits (*Monilia fructigena*, Pers.), potato rot. Figures fruit rot and apple injured (?) by Bordeaux mixture.

107. ——— **Fungous diseases of plants and their remedies.** Bull. Ohio Agr. Expt. Sta., second series, Vol. III, No. 4, April, 1890. Notices or defines briefly potato blight or rot, apple scab (quoting from Report U. S. Dept. Ag.. for 1889), pear leaf blight, powdery mildew of apple and cherry, and plum fruit rot.

108. ——— **The brown rot of the stone fruits** (with figures). The American Garden, Vol. XI, No. III, March, 1890, p. 165. Mentions attacks of *Monilia* on plums, cherries, and peaches with efforts made at Ohio Expt. Sta. to check same by use of copper compounds.

109. ——— **The potato blight.** Am. Agriculturist, July, 1890, p. 360, Vol. XLIX, No. 7. Discusses use of Bordeaux mixture and ammoniacal solution in treatment for *Phytophthora infestans*, DBy.

110. WATSON, B. M., jr. **Damping off.** American Garden, Vol. XI, No. 6, June, 1890, p. 348. Refers disease to *Pythium omnivora*, and gives preventive measures to be taken to avoid the trouble. Pricking off into fresh soil considered as the best remedy.

111. WOOLVERTON, L. **Treatment of apple scab.** Canada Horticulturist, June, 1890, p. 165. Sums up work done with *Fusicladium dendriticum*, Fckl., with special notice of JOURN. OF MYCOL., Vol. V, No. 1, p. 210.

112. ——— **The strawberry leaf blight** (with figures from Bull. XIV Cornell Univ.). Can. Hort., April, 1890, p. 109. Notices *Sphærella fragariæ*, Sacc., with review of Professor Dudley's article in Bull. XIV, Cornell Univ.

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